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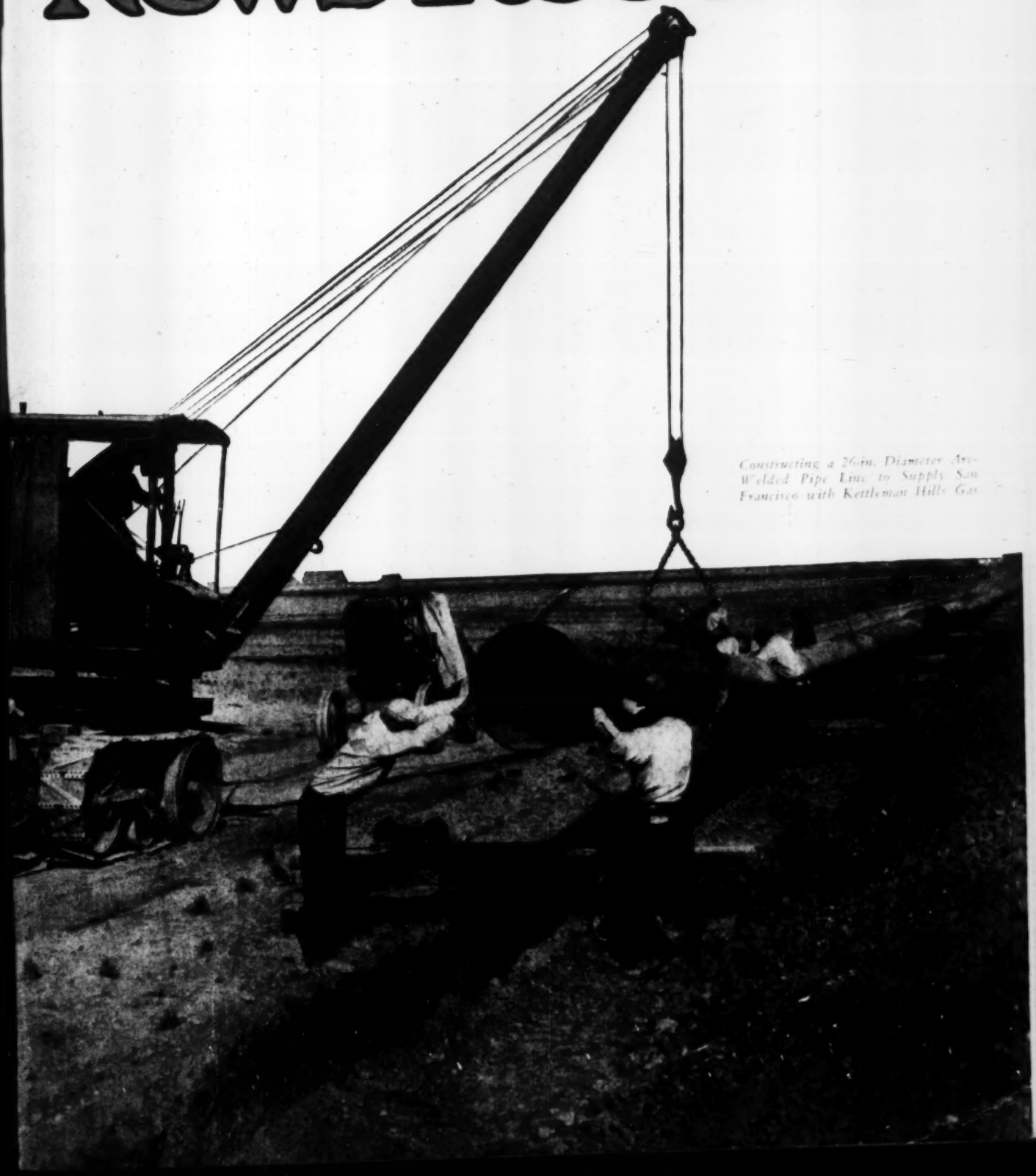

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ENGINEERING NEWS-RECORD

A McGRAW-HILL PUBLICATION — ESTABLISHED 1874

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, APRIL 10, 1930 Number 15

Eleven Billions Predicted

AMONG the early forecasts of 1930 construction the highest was that of *Engineering News-Record*, last November. The figure of ten billion dollars then given finds support, and more, in the prediction made a few days ago by Dr. Julius Klein, Assistant Secretary of Commerce, that a total of eleven billions may be reached this year. His estimate exceeds the output of the record year 1928 by 10 per cent. It appears optimistic; yet it indicates that even the languor of the dull months of December to March contains nothing to warrant a pessimistic or a cautious outlook. Let it be borne in mind, nevertheless, that construction expenditures mean work, and when measured in billions they mean a vast amount of work. During the first quarter a deficit has been accumulated, and if the predicted total is to be reached there will be need for energetic activity on the part of builders, of suppliers of material, and of labor as well.

Blasting Caps

FIVE HUNDRED children are killed or maimed in this country every year by playing with blasting caps, according to a four-year survey made by the Institute of Makers of Explosives. Each one of these casualties is the direct result of carelessness of those intrusted with the use and care of explosives. The construction industry is responsible for a great share of this tragic toll. Children playing around construction work often find the attractive and dangerous caps carelessly left in exposed places or in unlocked tool boxes and sheds. Statistics show that most of the blasting cap accidents occur in rural districts, where construction jobs are less apt to be guarded, and that they increase greatly in the spring and summer months, when the youngsters play out of doors. All contractors using explosives can, with little trouble, so safeguard their supply of caps that they will not fall into the hands of inquisitive children. By keeping their explosives locked up and accounted for they can do much to eliminate these preventable tragedies and supplement the endeavors of the Institute.

Literary Engineers

FRESH refutation of the old charge that the engineer's mind is limited to technical matters is given by two recent contributions to the arts by members of the engineering profession. Playgoers in Albany have lately been privileged to view a drama, by all accounts highly successful, straight from the pen of Col. Frederick Stuart Greene, superintendent of public works of the State of New York. And in Bethlehem, Henry S. Jacoby, professor emeritus of bridge engineering at Cornell University and author of many textbooks on structural practice, has successfully applied the principles of engineering research to an utterly alien field in producing a 680-page genealogy of the Jacoby family dating back to 1741, when the pioneer Jacoby landed at Philadelphia from Rotterdam. Thus is the tradition of engineering technical narrowness doubly shattered.

Justified Caution

IN THE light of recent developments at another dam site about six miles upstream, the procedure of the engineers in charge of building the Pine Canyon dam on the San Gabriel River is commendable. Although the site for this high-gravity dam for Pasadena's water supply already has been approved by geologists and explored by drilling, extensive additional exploration by tunnels is under way as a final check on foundation conditions before the construction contract is let. A complete cross-section of the formation will be obtained from the long tunnel now being driven under one of the abutments; since this tunnel is to serve as temporary diversion during construction and ultimately as the permanent outlet of the reservoir, no large preliminary expense is involved in the new exploration. Should such exploration reveal conditions so bad as to compel abandonment of the project, which otherwise could be determined only from the actual foundation excavation, the elimination of a canceled contract would go far toward writing off the cost of exploration. Some time ago, when commenting on the San Gabriel dam situation, we suggested the possible advantages of a separate excavation contract. The extent of the exploratory work now under way at the Pine Canyon site, in effect, is an example of the type of pre-contract caution alluded to. Circumstances warrant the belief that the state authorities will be exacting in their foundation demands at this location; accordingly a complete knowledge of conditions before binding the city to construction is prudent.

Federal Aid Increased

THE bill increasing federal aid for public roads has passed Congress and was signed by the President on April 4. Interest naturally centers in the additional money which the act provides. This amounts to $150,000,000 spread over three years, and under the law the states are required to match the federal appropriation. The $150,000,000 of the states will not be additional expenditure, however, for much if not all of it would have been spent in state roadbuilding had the additional federal-aid money never been appropriated. With an expenditure of a billion and a half yearly on public roads, federal aid counts small in the percentage column, even with the present increase of $50,000,000 a year. The true value of this aid is that it is concentrated on a trunk-road system of 7 per cent of the total road mileage, and that it establishes standards of administration and engineering whose influence extends beyond the fractional system of main highways to every state and county and township road. These facts are the fundamental

justification of federal aid. Its chief service to highway development is that it encourages and rewards good road engineering and not that it contributes a few dollars in a hundred of the money which the public pays for roads. It is important to the future of roadbuilding in America that this principle of federal aid shall be jealously guarded. Demands for wholesale contributions of federal funds for highways should meet positive refusal until the present federal-aid road system has been completed and thereafter unless federal direction and control of the money is made as absolute as now. In increasing for the next three years the amount of federal aid to the states, Congress has acted wisely in not meddling seriously with the governing law as it now stands. The only change made, which increases the maximum of federal aid per mile to $25,000 (from $15,000), applies only to the six states that now have improved their full 7 per cent system and are undertaking the costly steps of widening and supersurfacing. Thus the additional appropriation continues to be an encouragement and a reward for improved roadbuilding. Federal aid should at no time go beyond this purpose.

The Golden Gate Bridge

COMPLETION of test borings and other preliminaries for the proposed Golden Gate bridge has at last made available the data required for locating the piers and definitely estimating the cost of a structure having the unprecedented span of 4,200 ft. Opposition from taxpayers who objected to the financing plan has been fought through the courts and finally decided by the federal Supreme Court in favor of proponents of the bridge. There remains the major problem of raising the money with which to build the bridge. Voters of the Bridge and Highway District—which includes six counties but places 85 per cent of the total assessment in San Francisco—are to be asked, probably late next summer, to approve a bond issue of $30,000,000 for construction costs. Toll revenue from automobile traffic is expected to pay operating costs and refund the first cost. Engineers are interested quite as much in the financing program as in the technical phases of the project, and since their opinions have influence on popular voting in matters of this kind, it would be good strategy on the part of proponents of the Golden Gate bridge to find means of making sure that the project is presented in the right light to the local engineers. Two years ago an adverse attitude existed among San Francisco engineers, and such an attitude would not be helpful in a major bond-issue campaign that requires a two-thirds vote. In its technical aspects the project is distinguished by proposing the first long-span bridge in proximity to an active earthquake rift. Its location is roughly parallel to and about six miles from the San Andreas fault, whose movement caused the destructive San Francisco earthquake of 1906. Such a condition obviously raises intensely interesting questions as to tower stiffening and as to the effect of a major shake on towers, cables and suspended structure. As to costs, men of excellent repute in the bridgebuilding field say that a suspension bridge can be built as planned within the over-all cost estimate of $30,000,000, a surprisingly low figure. Larger sums are spent on many public projects with less argument and litigation than have attended this one. Hence detail questions of cost are less important now than diplomacy and the cultivation of the right public attitude toward the project.

Regional Public-Works Control

ENGINEERING works and utilities are increasing by such rapid steps, both in number and in geographical area covered, that they have gone far beyond the scope of existing local governmental agencies. The problems thus created await solution in all the densely populated sections of the country. Attempts at grappling with these have been undertaken only piecemeal, one district and one class of works or services at a time. What is required to meet the great expansion of pressing urban needs, both in variety and in geographical area, is a new and larger division of local government, best designated as regional.

The first state in the Union to recognize this pressing need for regional governmental areas is New Jersey. A bill now before the New Jersey Legislature deserves high commendation for its boldness and its novelty, while at the same time it is not radical. In fact, the bill is simply a logical extension of fundamental principles of municipal government, long in use throughout the country, restricted in this bill to public works and utilities.

The bill recognizes the fact that in New Jersey city and county alike are unable to cope with the urban needs of today—much less of those of tomorrow for which immediate provision must be made. The bill also recognizes that the whole state, in varying degree, has interurban problems. Therefore the bill proposes to divide New Jersey into four regional districts, of which two would come into existence with the passage of the bill, because needed immediately, and the other two would wait on local initiative and then approval on referendum vote, both by more than half of the counties concerned.

So long as operations are confined to public works and utilities, one of these regional districts can do anything affecting two or more cities, towns, boroughs or counties that one of these alone or two or more together could do, or that, in some respects, a private utility company could do; and in much the same way. The district governments would also be under much the same state control as are the existing but smaller local government areas. Division of the entire state into regional districts, bounding the districts by county lines and making the districts simply greater municipalities for the provision of public works and utilities, needed either by the entire district or portions of it, and leaving the cities and counties to decide for themselves whether they would contract with the regional districts, are all commendable features of the bill.

Passage of the bill is urgently needed in New Jersey, particularly for the proposed North Jersey district, because that district has large water supply, sewerage, flood and mosquito control and transit problems. There have been some achievements in providing joint water supply and sewage disposal facilities, but under serious handicaps and with unseemly wranglings and long and costly delays. Regional transit and flood control in New Jersey are baffling problems under existing conditions. Flood control has been reported on repeatedly for 40 years. The latest commission, which reported quite recently, advised a $100,000 appropriation for still further investigation, but after its report was in print adopted a supplementary recommendation in favor of turning the problem over to the projected regional district. Better transit facilities within the district are urgently needed. The subject has been under investigation for several years by a suburban transit commission. That body has just advised the

legislature to have further studies made by a regional planning commission. Much the same thing is proposed by still another investigating commission, covering Essex and Hudson counties, which include Newark and Jersey City.

The tide sets strongly toward regional governmental districts for planning and providing public works in New Jersey. Municipal consolidation is abhorrent. District agencies have been found wanting. Counties are too small a unit. Regional government for public works has become imperative. But New Jersey does not stand alone in this need. The bill pending in the New Jersey Legislature promises urgently needed relief to that state and would serve admirably as a model for other states.

Public Officials and Cut-Rate Engineering

RETAINING an engineer in a consulting capacity is the same in principle whether the retainer is made by a private organization, a state government or a department of the federal government. A private corporation would not think of asking an engineer to take part of his pay in glory, and the state has no moral right to do so. A committee of the American Society of Civil Engineers which recently reported on this subject pointed out that there is no more reason to expect governmental service to be performed by engineers for inadequate compensation than to ask that political appointees serve without compensation.

Some states in which it has been the practice to get the best talent available for consulting engineering work have been handling these appointments in such manner as to avoid payment of compensation altogether or else to pay an inadequate rate. The method of accomplishing this low-rate retainer in some cases has been as follows: A consulting engineer receives a telegram or long-distance telephone call advising him that the Governor wishes to appoint him on a consulting board to review such and such a project, and asking if he would be willing to serve. No mention is made of compensation. The next move is a statement given to the press from the state capital, naming members of the new board and announcing that the appointments have been accepted. Thus the engineer finds himself committed to the service. When the board holds its first session, the state representative who gives the instructions thanks the individuals for being willing to undertake a work of great public benefit and explains that of course they all understand the state has no funds with which to pay fees and that it is possible to pay only expenses and $25 per day.

At this stage of the procedure it is too late for the individual to withdraw gracefully. Those who previously have had a similar experience may pocket their pride and console themselves with the thought that when business is dull the cut-rate pay is better than nothing. Because the state sanctions the practice, the engineer purposely or otherwise overlooks the fact that acceptance of such fees is helping to continue a practice most demoralizing to professional standards.

Unfortunately, the use of this plan has been extended and intensified of late. Some departments of the federal government and some state officials now expect to get consulting advice for half or even one-quarter of the usual rate. Knowing that such fees are inadequate and unfair, some engineers decline later appointments. But these men are readily replaced by others inducted into service by the methods already described. Anyone who demurs at the low fee is reminded that it is a great honor to be chosen for such important public service and that he should be appreciative of the professional prestige accruing from such appointment.

It is a proper function of the American Society of Civil Engineers to look into and make definite recommendations on this situation. In recent months, state projects running into hundreds of millions of dollars have been passed upon by boards of consulting engineers who were receiving one-quarter the usual rate. Consulting engineers are rapidly reaching a point of view where they resent the injustice in the attitude of states and federal departments that expect cut rates. Whether the disguise is classed as charity, patriotism or "glory" makes little difference. Cut rates are not creditable to the officials involved. It is time the practice were stopped.

Condemn or Condone

ALMOST unfortunate controversy between architects and engineers in New York State is drawing to a close. It has been marked by unprofessional disputes before the Regents of the University of the State of New York (under whom all professional laws are administered) and before legislative committees, all tending to lower the standing of both professions in the eyes of the public. Through it all has run a growing impression that the controversy was not a chance happening but that it resulted from a definitely planned campaign to restrict engineering work in the building field to industrial work, leaving architects in undisputed control of buildings in general.

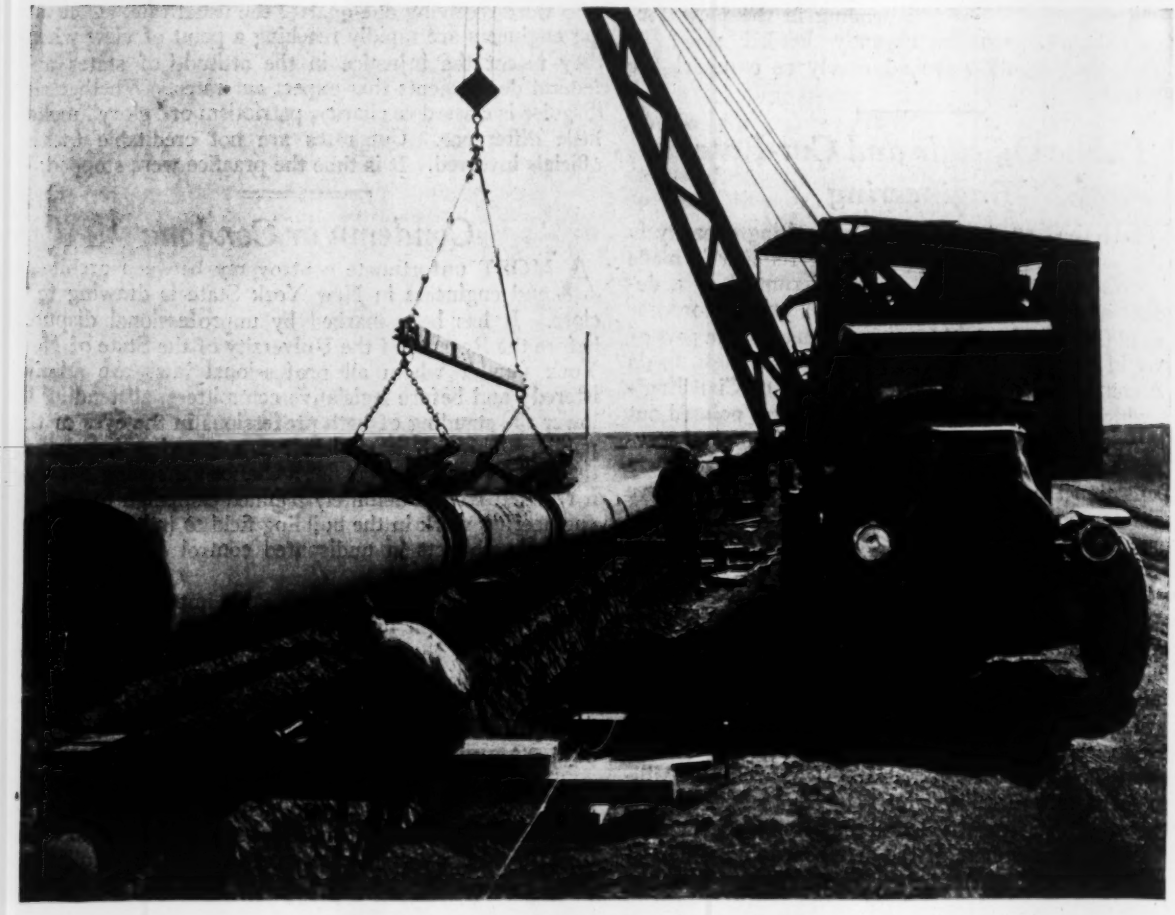
Evidence in support of that early impression piled up as the weeks went by, until last week it was established beyond doubt that the campaign was being carried on with the full knowledge and approval if not actually under the direction of three members of the architects' board of examiners, one of whom is the regional director of the American Institute of Architects.

The campaign has been marked by numerous actions upon the part of architects which are a discredit to the profession. Some of them have been the subject of comment in these columns heretofore; others have followed. They cannot now be put aside as acts of irresponsible men for which the profession as a whole may not be held accountable. While unquestionably the men of high ideals in the architectural profession have been unaware of the full import of what has been going on, responsibility for some of the most reprehensible actions is now fixed beyond doubt upon men who are supposed to be leaders in the architectural profession. The profession, therefore, must either condemn or condone what has been done. This is especially true of the American Institute of Architects, which organization is directly involved.

Efforts to get the two professions back upon a basis of co-operation which already have been started by responsible men on both sides should be continued. They cannot continue so long as either party discards the ethical standards which govern dealings between men and which above all should govern interprofessional relations. The architectural profession must declare its position; either it must openly or by its silence give its approval to what has been done or it must express disapproval of what has occurred and thereby open the door to the restoration of amicable relations.

Constructing a Natural Gas Line of Record Size

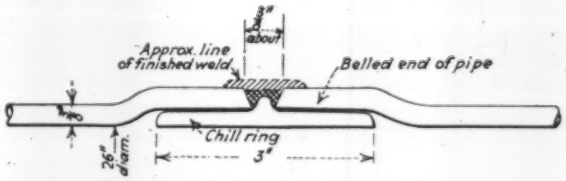
26-In., 200-Mile Line From Kettleman to San Francisco Arc-Welded and Laid at Rate of One Mile Per Day Per Crew as Result of Synchronized Construction Operations



PLACING AND TACKING PIPE INTO SECTIONS
Ten 40-ft. lengths put on dollies for the rolling welders.

ACCELERATING fieldwork by carefully synchronizing the various construction operations, crews are laying one mile of pipe per day on the record-size 26-in. natural gas line being built from the Kettleman Hills field to the San Francisco Bay region. The 200-mile line will have a capacity of about 138,000,000 cu.ft. per day, which will supplement the supply furnished by the present 20-in. line and permit expansion of this service to Stockton, Sacramento and communities in north central California. Ownership of the line will rest jointly with the Pacific Gas & Electric Co. and the Standard Oil Company of California under the name of the Standard Pacific Gas Line, Inc. Construction features of this second natural gas line to be built within a year by reason of the discovery of the Kettleman Hills field, described in the March 27 issue, are interesting because of the record size of the line and the speed being attained in welding and laying. A description of construction work on the original line appeared in *Engineering News-Record,* June 11, 1929, p. 54.

The new line is of 26-in. diameter electrically welded steel pipe for the major portion of the distance, this being the largest size pipe of this type it seemed feasible to specify at the time. Before formation of the joint organization a 22-in. line already had been started by one of the companies and the other planned a line which would tend to duplicate this service. The agreement resulted in a decision to build a single line of the largest capacity possible as a measure of economy. The size of the line under construction was ordered changed to 26 in., but since this size of pipe could not be supplied at once, the 25-mile gap between the two already completed 22-in. sections was built with 24-in. pipe. The next 120 miles of the line to the north, built of the large-size 26-in. pipe, extends to the location of the first major branch, beyond which junction the size of the pipe is re-



SKETCH SHOWING DETAILS OF WELDED JOINT

duced to 22, 20 and 12 in. as other branch lines are served.

Field methods used by crews of the Pacific Gas & Electric Co. on the large 26-in. pipe are described in the following. Construction organization consists of two separate crews of about 175 men each. Each of these crews welds and lays approximately one mile of line per day, working out of camps located at about 40-mile intervals. The maximum round trip to and from the work is, therefore, about 40 miles, and because of the rush nature of the project, the crews leave camp at daybreak and return at dark. This permits a working day of about ten hours and the men are paid from the time they leave camp to the time they finish the day's work at the job.

Speed of construction is dependent upon synchronizing the crew operations in performing the numerous steps of the work. Efforts are made constantly to improve the organization so that the various steps will move at the same speed without conflict or lagging. This organization work has resulted in increasing the daily output until the sustained production of one mile per day is possible under ordinary conditions. When any step of construction is found to be lagging behind the others, efforts are made to improve this operation by new equipment or changed methods to bring it up to average speed. The double organization tends to promote rivalry and the resulting spirit is in large measure resposible for much of the crew efficiency.

Pipe and Trenching—The pipe consists of 40-ft. lengths of 26-in. diameter electrically welded steel pipe, $\frac{3}{8}$ in. thick. The weight of the pipe is about 100 lb. per foot, or approximately 2 tons per length. Shipped by trainload from Eastern point of manufacture, ten freight-car loads are required per mile of line. From nearest rail point the pipe is transported under separate contract by truck and trailer to the right-of-way and strung out well in advance of the construction work.

TYING-IN CREW CONNECTS SECTIONS
Tractor pulls 20-ton sections together, welding done without rolling.

The pipe is not allowed to be dropped or rolled from the trucks, but must be lowered carefully to eliminate possibility of damaging the ends.

The trench is dug by a ladder-type trencher except in a few places, where rock excavation is required. The width of the cut is about 32 in. and the depth varies from a minimum of slightly more than 4 ft., to provide the minimum coverage of 2 ft., to a maximum of about 6 ft. The excavator operates 24 hours per day, several miles in advance of the pipe-laying crew to insure against stoppage of the major operations in case of breakdown. Where the ground has slight irregularities, a tractor-drawn grader is used to strike off the ditch line so that the trencher can cut more uniformly to the grade line laid out.

Stringing and Tacking—Steps preliminary to the major welding operation consist of placing the pipe lengths on

ROLLING WELDER CREW UNIT AT WORK
Welder, helper and tong-men finish twenty welds per day.

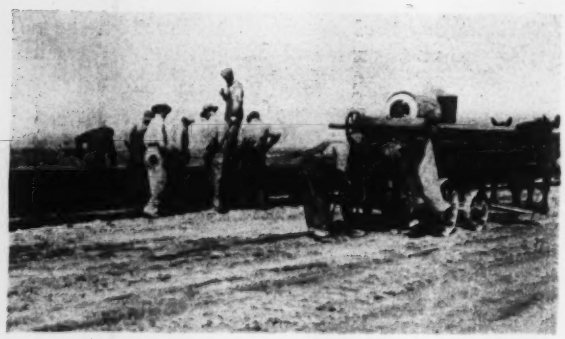
skids over the trench and tack-welding them together into sections of about ten lengths each. Supporting timbers are placed across the trench as they are distributed by a truck which brings them forward from a point about 3 or $3\frac{1}{2}$ miles to the rear where the completed line is being laid. Setting the supporting skids to grade is an important step to insure that the section can be revolved easily without strain at the tacked joints as the rolling welding is done. Ten lengths to a section is the maximum for convenient rolling, and where uneven ground would require extensive cribbing to place the skids on grade this number is reduced. After the timbers are set to grade an inverted dolly with four wheels is set on the skid for the pipe to rest in.

The pipe lengths are handled by a truck-mounted crane which moves beside the trench, lifting and placing them in the dollies. The joint between lengths includes a bell on each pipe and a chill ring which is fitted into the bell of the pipe in the dollies just before the other length is put into position for the first tack weld. Details of the type of joint used are shown in the accompanying sketch. The use of double bell and chill ring eliminates direct pressure on the welded joint and greatly facilitates the welding process.

The pipe is held by the crane while a tack-weld is made at the top of the joint and then it is eased onto the dolly. With pipe tongs a crew of two or three men rolls the section about 180 deg. and another tack-weld is made. The generator furnishing current to the tack-welder is fastened to the truck crane. To set up one mile of pipe per day this crew must handle 132 lengths in ten hours, or at a rate of one length in less than five minutes.

This operation is shown in an accompanying illustration.

Welding—The major step in the construction program is the process of field-welding the joints. The speed and efficiency of this part of the work is the governing factor, both as to economy and rate of production. By arrangement with the A. O. Smith Corporation, of Milwaukee, which furnished the pipe, crews of experienced welders were brought from the plant to do the field-welding. As organized, each crew consists of eleven welders, twelve generator sets, one maintenance man and a foreman. The efficiency and speed of these welding crews, according to officials of the Pacific Gas & Electric Co., are important factors in attaining the present daily construction progress. When working at rolling welding,



PAINT CREW ADVANCES AT A WALK
Pumped from the kettle, asphaltic paint is applied with brushes.

members of these crews make twenty welds per day. Based on its recent experience in building the first 20-in. line, the company estimates that acetylene welders would not complete more than three such welds in the same time.

Each of the six rolling welders works on a section aided by a helper and the two or three men who turn the pipe by means of tongs. Use of roller-bearing dollies by one crew allows a ten-length section to be turned with two men at the tongs. Dollies with plain bearings, used by the other crew, limit the section to nine lengths and require three men at the tongs. As the pipe is rolled the welder works continuously at top welding, filling the joints nearly flush with the surface of the pipe for the first weld. Moving to the next joint, he makes the next weld while the helper cleans and knocks the scale from the weld just completed. Finishing the first series of welds, he places a second weld on each joint to bring the surface about $\frac{1}{8}$ in. above the pipe for a width of about 1 in. These welds are completed at the rate of less than fifteen minutes per circle, or approximately twenty complete joints per ten-hour day. Cable from the generator set is sufficient for a complete section without moving the set. When these welds are completed, horses move the generator to the next section.

Tying-In and Testing—Immediately following the welding of each section, the pipe is jacked up off the skids and the dollies are removed. The skids are then greased to permit easier movement when the sections are pulled together for the tying-in operation. Greasing is not done to reduce the power required to move the pipe so much as to make movement smoother. Pulling is done by means of tractors and the sections are first tacked together, after which the welds are completed without turning the pipe. This requires bottom welding, and the work is done by those members of the crew qualified for this more difficult type of work. Organization of the tying-in crew, in common with every other step of the work, conforms to the program of completing one mile per day.

With completion of the tying-in of the one-mile section to form a completely welded steel tube it is ready for testing before being placed in the trench. Testing is done by pumping the line to 100 lb. of air pressure with truck-mounted compressors, using a removable test head described in the article on the original 20-in. line. It has been found economical to use the air released from the previous test section to place about 40 lb. of pressure in the new section. The remaining 60 lb. of pressure is supplied by the compressors, after which the circumferential joints are all tested with soapsuds. Because of the high grade of welders and shop tests proving the high average strength of the welds, the latter are not tested for strength in the field. The line is designed for a working pressure of about 400 lb.

The pipe line, after testing, is painted with a prime coat and a second coat of asphaltic paint as it rests on the skids above the trench. A horsedrawn paint kettle is moved along the line and the coating applied by a crew with brushes as shown in an accompanying illustration.

After painting, the pipe is ready for laying. It is picked up at successive points with a crane which is equipped with a stiff-leg at the end of the boom to provide stability. Skids are removed and the paint coat patched where necessary. The pipe is then lowered into the trench and is ready for backfilling.

No allowance for expansion is made in the line, it being the company's practice to lay the pipe in compression. At about the midpoint of each 4,000-ft. section the pipe is left up on the supports above the ditch to provide slack in the line. This "hump" is lowered during the cool, early morning hours and produces compression in the line sufficient to make expansion joints unecessary. Small vertical bends in the line are provided for by using a corrugated section of pipe commonly used as an expansion joint but, in this case, successfully used for the other purpose. Valves are set in the line at about 5-mile intervals.

The foregoing description of the welding and laying procedure is typical of the level and gently rolling country common to the major portion of the line. For some short stretches, however, the topography is not so favorable. Digging, except in a few places, can be continued with the trencher, but the truck-mounted crane for handling the pipe is not feasible in rough country and

PLACING PIPE IN TRENCH PRIOR TO BACKFILLING
Note flexibility of line weighing more than 100 lb. per foot.

more handwork is required. Often the sections tacked together for the rolling welders are shorter because of steeper grades. Welding procedure follows the same general steps. In rougher country the interval between valves is reduced to 2 miles.

Joint Organization—The plan for joint ownership and operation of a single large-capacity natural gas line was a conservation measure effected by the two companies to save the gas consumers of central California the cost of duplicate service. Prior to the agreement each company planned a pipe line (construction work on the Pacific Gas & Electric Co. line of 22-in. diameter already had been started) to cost more than $8,000,000 apiece. Details of the agreement were worked out under the direction of K. R. Kingsbury, president of the Standard Oil Company of California, and A. F. Hockenbeamer, president of the Pacific Gas & Electric Co.

For the Pacific Gas & Electric Co. work is being done under the supervision of W. S. Yard, vice-president in charge of gas construction and operation, with R. S. Fuller, engineer of distribution, in direct charge of the project. R. V. Wilson, assistant engineer, and R. A. Hansen, field superintendent, are in charge of the construction forces.

Ingenious Construction on Mill Street Bridge, Watertown, N. Y.

Structural Steel Ribs of Concrete Arch Hung From Old Bridge During Erection and Later Made Hingeless to Carry Forms and Concrete

By E. H. Harder
Concrete-Steel Engineering Co., New York, N. Y.

IN REPLACING the old three-hinged steel arch bridge crossing the Black River on Mill St. in Watertown, N. Y., with a reinforced-concrete arch, interesting problems of design and construction were solved. The old steel arch bridge built in 1897 (*Engineering Record*, March 5, 1898, p. 294) had become inadequate to carry modern live loads and had deteriorated somewhat because of an almost constant spray from a dam and waterfall a hundred feet or more upstream.

The old steel arch had a span of 165 ft. and a rise of 15 ft. 3 in. The end shoes abutted against the walls of a laminated limestone gorge high above the natural level of the river. About 38 ft. below the roadway two ledges of a more massive limestone formation extended from the vertical rock walls toward the middle of the river. The bed of the river between these ledges is deep and full of pieces of broken limestone. Because of this condition and also because of frequent floods, the erection of centering would have been difficult and risky, and at best some form of arched centering would have been required.

Simply stated, the problem involved the reconstruction of a private penstock and turbine located beneath the north end of the bridge, the utilization of the lower limestone ledges and the building of a reinforced-concrete arch bridge above these ledges and under the old

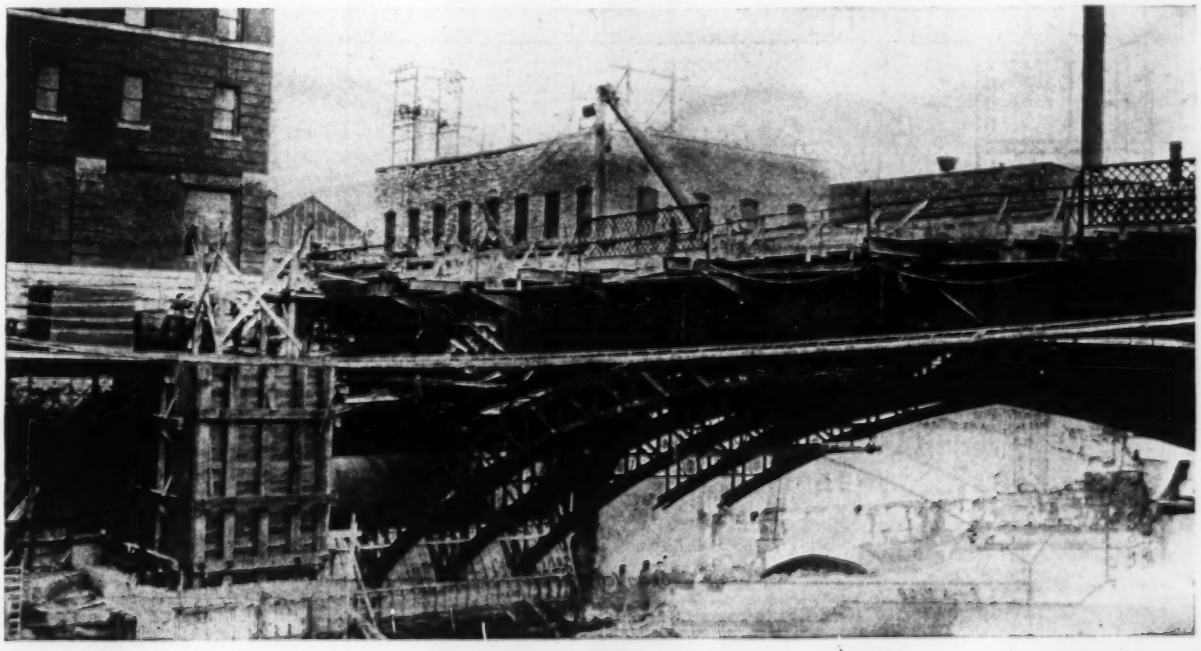


FIG. 1—CONSTRUCTION AT NORTH END OF MILL ST. BRIDGE
Three reinforcing ribs are concreted in. The remaining two ribs await demolition of old concrete buttress. Timber housing of old turbine shown at left.

steel bridge. These features of the problem are shown in Fig. 2, which gives an indication of the relation between the old and new bridges.

For economy the old bridge was used to its maximum extent. It was well known beforehand that forms to carry the concrete of the new ribs could not be suspended from the old bridge because of the inadequacy of some of its members. The old bridge was, however, strong enough to carry five sets of steel reinforcing ribs after the removal of the old roadway and sidewalk. Consequently it was decided to utilize structural steel reinforcing in the new arch and design the steel ribs with sufficient carrying capacity to carry the weight of the forms and the rib concrete and still have sufficient surplus of area to act as reinforcement to the rib concrete for carrying the live load and the remainder of the dead load. Usually such structural steel ribs are designed as three-hinged arches because of the complicated adjustments necessary to make closure at the crown and to induce dead-load stresses in the members when a hingeless steel arch is built out from fixed abutments. To avoid such adjustments and for ease of erection, the ribs were suspended at frequent intervals from the old bridge by hangers. After riveting all splices the ribs were adjusted to proper height by raising or lowering the hanger rods. With the ribs thus erected, they were concreted into the abutments and upon release of the hanger rods swung free as hingeless steel arches.

FIG. 3—REINFORCED-CONCRETE RIBS COMPLETE
Old steel arches rested on the new ribs during demolition.

At the south end of the bridge the five ribs were

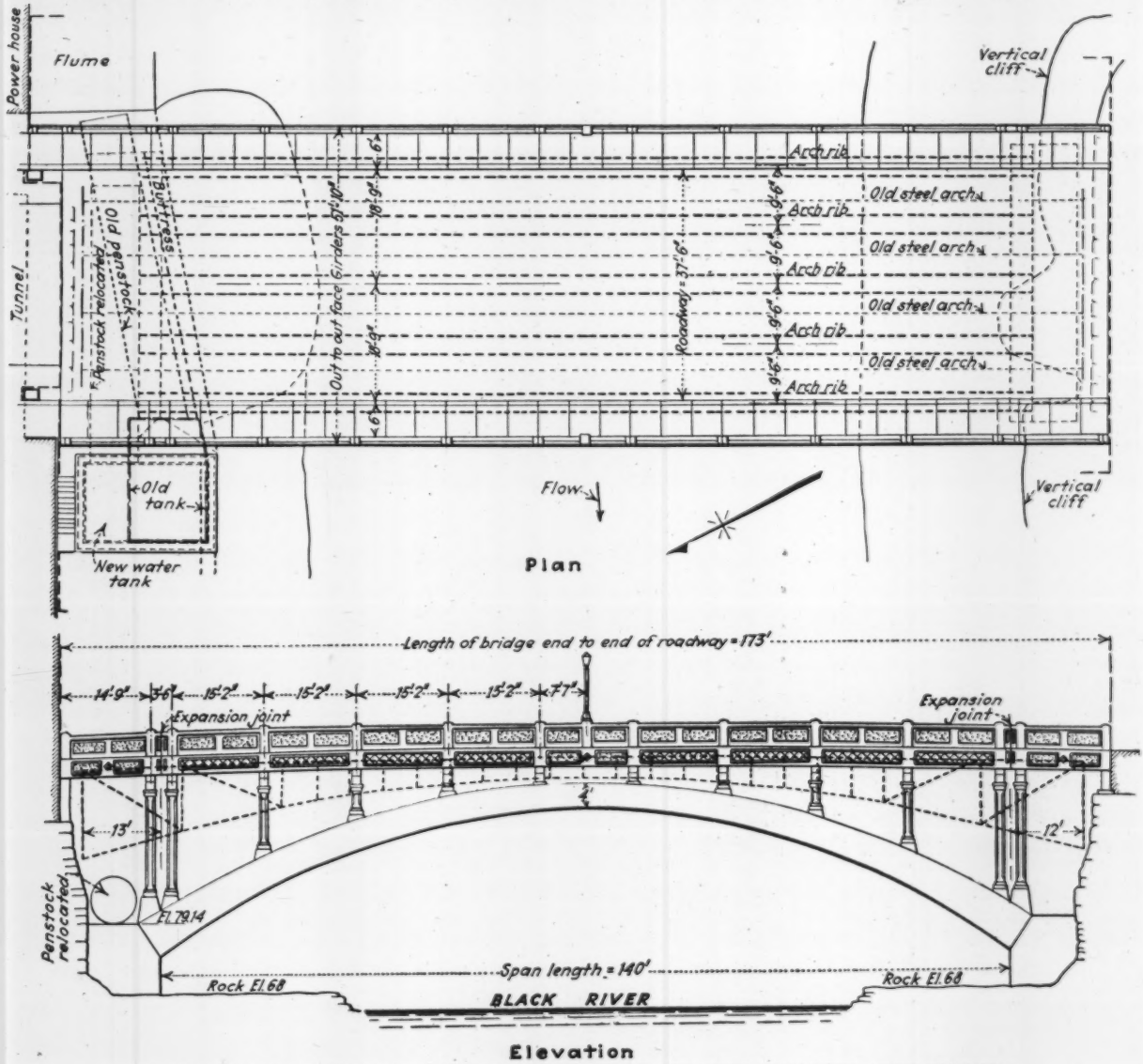


FIG. 2—RELATIVE LOCATIONS OF OLD STEEL BRIDGE AND NEW CONCRETE ARCH BRIDGE, MILL ST., WATERTOWN, N. Y.

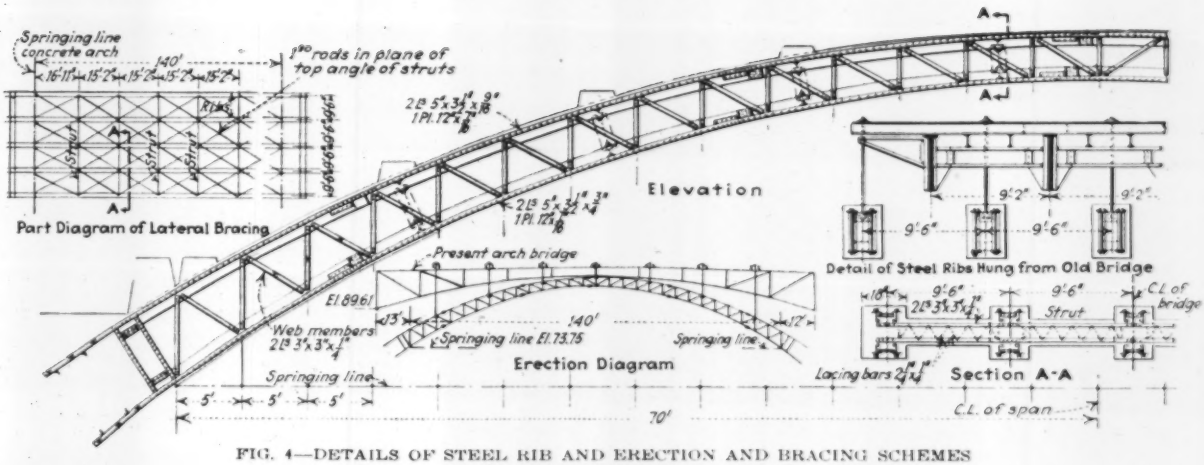


FIG. 4—DETAILS OF STEEL RIB AND ERECTION AND BRACING SCHEMES

concreted into the abutment in one pour. At the north end of the bridge it was necessary to safeguard an adjacent flume by temporarily maintaining the original buttress wall, so that at this end of the bridge the three westerly ribs were concreted into a little more than one-half the width of the abutment, from which temporary shores were erected to hold the west flume wall. This being done, the old concrete buttresses were removed and the easterly pair of ribs completed and concreted into the remainder of the north abutment. During the preparatory stages the old penstock had been relocated and a new housing built for the turbine.

After erecting the ribs and fixing the ends in the concrete abutments, the concrete forms (Fig. 5) were suspended from them, permitting completion of the new arch ribs. Following the removal of the old steel, the remainder of the new bridge was rapidly completed.

One objection raised to the use of structural steel ribs where the total weight of the forms and concrete has been suspended from them is that the pouring of the successive sections of concrete in the ribs will increase the stress in those sections already poured to such an extent that the bond between the concrete and steel in these sections may be impaired, particularly if the concrete is green. To lessen such tendency, high-early-strength cement was used. Another feature adopted was the inversion of the flange angles from the usual position. In past experience with such steel ribs, when the outstanding legs of the flange angles were 2 to 3 in. from the face of the arch, it was found that the concrete under the ribs on the surface of the soffit seemed to have a different character from that between the ribs. The location of each rib could always be plainly seen. To avoid this unsightly appearance the short legs of the flange angles were turned toward the extrados and intrados surfaces, which facilitated the placing of the concrete and provided a greater mass of concrete above and below the ribs. The moment of inertia of the steel sections is reduced somewhat, but not enough to become a hindrance to the design as a whole. The design provided for an average bond stress between steel and concrete of 12 lb. per sq.in.

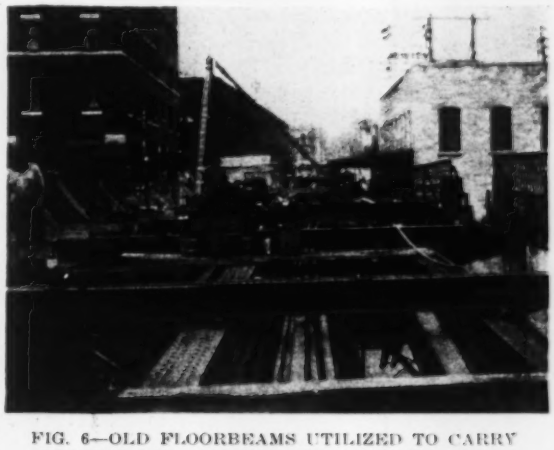


FIG. 6—OLD FLOORBEAMS UTILIZED TO CARRY REINFORCEMENT FOR NEW CONCRETE ARCH
Note round hanger rods extending below transverse beam in the foreground.

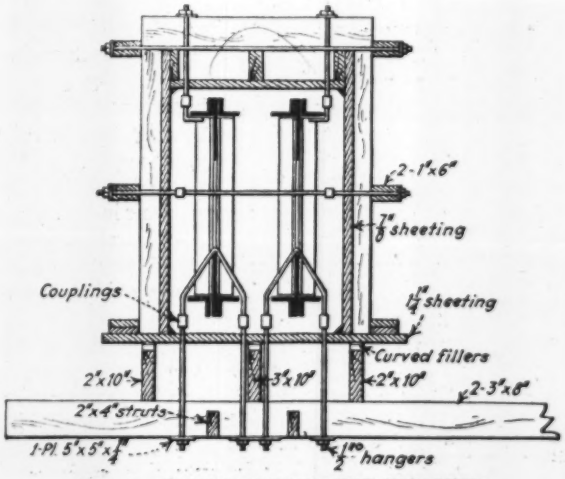


FIG. 5—CONCRETE FORM FOR INCASING STRUCTURAL STEEL RIBS

The various sections of the steel ribs were designed in accordance with the usual specifications. Cognizance was taken of the bending produced in the rib flanges because of the curvature between panel points. Transverse stiffeners were provided not at panel points of the ribs, but at the location of the deck columns. The diagonal braces between the ribs were cut off after the arch ribs and transverse stiffeners had been concreted.

The bridge was designed by the Concrete Steel Engineering Co., New York City, and was built by the Peckham Construction Co., Buffalo, N. Y., whose low bid of $75,489 was accepted by J. Walter Ackerman, city manager of Watertown. The construction work was supervised by the city engineer, Paul B. Sutton, and by Donald H. Breen, resident engineer.

Earthquake Resistance Provided in Design for Gravity Dam

Pine Canyon Dam to Withstand Horizontal Acceleration of One-Tenth Gravity With Reservoir Full

EARTHQUAKE-RESISTANT provisions are being incorporated in the design of the Pine Canyon dam, to be built on the San Gabriel River as part of a water-supply project for Pasadena, Calif. Preliminary plans call for a concrete gravity dam, straight in plan, 295 ft. high above streambed and 375 ft. above lowest foundation. The structure will contain approximately 700,000 cu.yd. of concrete, and the reservoir capacity will be 64,200 acre-ft. Exploration tunnels and shafts are now being driven at the site and the details of design will be based on the results of this exploration work.

Investigation of the economic possibility of providing an earthquake-resistant design was made by S. B. Morris and C. E. Pearce, chief engineer and designing engineer, respectively, of the Pasadena water department. Results of these studies, including an outline of the mathematical analysis, were given in a paper presented before the Seismological Society of America. The design principles advanced in the paper and the resulting effect on the cross-section of the Pine Canyon dam are outlined in the following.

The dam site is situated on the San Gabriel River about 6 miles below the Forks site of the Los Angeles County Flood-Control District. The rock in the vicinity consists of a granular gneiss, proved by tests to be sound and strong. About 17 miles north of the site, on the other side of the San Gabriel Mountains, lies the San Andreas fault, which is known to be active. Approximately 13 miles to the south is the Whittier fault, which also is considered active. Two other lesser faults within a few miles of the site give no evidence of present activity.

Earth Movement Data Few

Data for fixing the probable maximum acceleration of earth movement to be expected at the site are few. Computations of probable earth acceleration, however, have been prepared by geologists from effects of the California earthquake of 1906 and the Japanese earthquake of 1923. These estimated values show a range from as much as $0.4g$, or 13 ft. per second, in sandy or marshy ground to $0.1g$, or 3.2 ft. per second, in solid rock. From this rather scant information, and the advice of geologists, a maximum acceleration of $0.1g$ in the foundation rock at the Pine Canyon site was adopted.

The horizontal component of this acceleration acting upon the dam may tend to increase the vertical compressive stress and the horizontal shearing stress. In either case it can be shown mathematically that the increase in the stress is directly proportioned to the height of the dam for constant values of acceleration. Therefore the horizontal force of the earthquake acceleration may be considered as a triangle of force acting upon the face of the dam similar to and in addition to the water pressure when considering overturning with reservoir full.

The magnitude of this increase in stress for a 375-ft. dam is 20 lb. per sq.in. in shear and 50 lb. per sq.in. in vertical compression. In either case this additional stress in the concrete is not of serious proportion. However, in the case of a gravity dam, it is important to note that the 50-lb. increase in compressive stress at the downstream toe will reduce the upstream heel reaction. With reservoir full, the usual design provides for practically zero compression at the latter point, and therefore provision must be made to eliminate the possible tension in case of earthquake.

Base Widths Calculated

For the Pine Canyon dam, using 150 lb. per cubic foot as the weight of concrete, with an uplift pressure decreasing from 50 per cent at the heel to zero at the toe, the ratio of base width to height was calculated for various values of earthquake acceleration. Beginning with a base width of $0.725h$ when earthquake acceleration is absent, assumed values of 0.1, 0.2, 0.5 and $1.0g$ were found to require base widths of 0.793, 0.87, 1.11 and $1.6h$ to satisfy proper gravity dam requirements. For the selected acceleration of $0.1g$, a base width of $0.80h$ was adopted, which represents a 9.38 per cent increase in the volume of the dam.

The vertical acceleration due to earthquake motion has no overturning effect upon a gravity dam. The weight of water and its pressure on the dam increase during upward acceleration and decrease during downward acceleration of the earth. Unit stresses in the foundation are accordingly increased and decreased, but there is no tendency to overturn. With an acceleration of $0.1g$, the compressive stresses are increased about 10 per cent. The customary large factor of safety as to compressive stress, common to gravity dams, makes an increase of 10 per cent due to earthquake acceleration unimportant; it is not considered in the present case.

Possible harmful action of the stored water on the dam when and if it actually moves back and forth due to earthquake shock has been suggested in the belief that such a force would act as a "soft-nosed battering ram of relatively great weight." In the present case if the earthquake acceleration is considered to have uniform harmonic motion with a period of one second, the maximum velocity attained is 0.518 ft. per second. Considering the water to remain stationary and the dam to move against the water with this velocity, the force exerted upon the dam will be twice the velocity head, or 0.008 ft. additional water head. For the conditions in question such a force is believed to be negligible.

Conclusions

As a consequence of the investigation of earthquake possibilities at the Pine Canyon site, the structure has been designed to resist a horizontal earthquake acceleration of $0.1g$. This has necessitated increasing the base width to 0.8 of the height, which adds 9.38 per cent to the volume of the structure; this increase applied at the downstream toe is sufficient to eliminate tension at the upstream face of the dam when the reservoir is full. With reservoir empty, such an earthquake acceleration would produce 50 lb. per sq.in. tension at the downstream toe, but since this presents no hazard it is not provided against in the design.

The problem of determining the force due to the oscillation of the dam against the water in the reservoir is worthy of further investigation, both by mathematical analysis and by experiments with models on a shaking table. It is recommended that provisions against earthquake shock should receive consideration in the design of all dams where such forces are expected.

Engineering in Five Kansas Counties

Two Articles Setting Forth Practices of Wide Applicability Found on a Recent Reconnaissance Into the State

By Waldo G. Bowman
Assistant Editor, Engineering News-Record

II—Practices in a Wheat-Belt County and in One Adjacent to Kansas City

COUNTY engineering in Kansas is not in principle different from that in any other state, excepting always the work in such metropolitan counties as Cook in Illinois, Westchester in New York, Allegheny in Pennsylvania, Jackson in Missouri and Los Angeles in California. Engineers of small-town counties, the nation over, are confronted with the composite task of providing good low-cost highways, of handling drainage problems, of solving the numerous technical questions that beset our rural governments—and usually the task is complicated by lack of funds. Often, too, politics harass the engineer when he has need for unhampered movements. But in spite of handicaps, many counties are doing jobs comparable in efficiency to those of our best city and state governments.

County engineers are of necessity resourceful, and have developed many useful job and office methods. In the five counties considered in these two articles, widely different practices are apparent. In the March 20 issue the practices of a county in which the engineer's office handles all design and construction were described along with those which have been developed in a county which retains a consultant for all major design work. In the present article the reader can make a comparison between methods used in a large prairie-farming county and those necessary in a county contiguous to a large metropolitan area. In addition, an interesting utilization of local gravel for all-weather roads is described.

County engineering is in need of technical advice. Its literature is scant. With growing appreciation of modern highways and other engineering works on the part of the public, the county engineer will benefit from an increased interchange of experiences with his colleagues in other counties throughout the country. These two articles, of which this is the second, have been planned to assist in this interchange of knowledge, as have other articles published recently in these pages: Caddo Parish, La., Aug. 29, 1929, p. 328, and Mecklenburg County, S. C., Oct. 10, 1929, p. 576.

FIG. 1—DIRECTION SIGN ON A COUNTY HIGHWAY SYSTEM

County engineering in Reno County, Kan., involves the construction and maintenance of a 250-mile system of earth highways, the supervision of work on a 2,000-mile township system (soon to become an integral part of the county system), the making of all legal and private surveys outside the county seat, flood-protection work and drainage district development and construction. The county engineer usually has something to say about every other county project also. For instance, he has made all borings for a new court house to be built next year and will in all probability be connected with the actual construction. All work, including bridge building, is done by force account, one of the compelling reasons being the necessity for having available at all times a force of men sufficient to cope with flood and snow conditions which arise suddenly in the county.

Reno County is unusually flat and much of it is subject to periodic floods by small creeks and by the Arkansas River, which runs diagonally across the county. Wheat farming on a large scale is the principal industry. The largest town and county seat, Hutchinson, has a population of about 30,000, and is a wheat elevator and milling center. Also, it is a distributing point for the Southwest for many farm-equipment companies, and is said to be the largest salt-mining center in the country. All other towns in the county have a population of 1,200 or less, so that Hutchinson is the focal point for trade and, therefore, for county highways.

When the new highway law went into effect in the state, Reno County turned over a 150-mile system to the state highway department. Of this, 78 miles was paved, constituting the largest hard-surfaced mileage in any county in the state. Part of this pavement, 54 miles, is monolithic brick, the base being 5 in. of concrete. This was laid in the boom periods of 1919-22 and cost about $48,000 per mile. The remaining 24 miles, of 18-ft. concrete pavement, built by the county for the state, averaged about $22,000 per mile. Local bank-run

gravel and sand were used as aggregate on 16 miles paved in the past two years, and, utilizing a water-cement ratio of 4.9 to 5.25, an average 28-day strength of 4,200 lb. was obtained.

Special Roads for Farm Machinery—The present problem of W. A. Stacey, the county engineer, is to develop a surface for his dirt roads that will be satisfactory. A good start has been made, in that nearly the whole of the present 250-mile system is graded. A 60-ft. right-of-way has been acquired on all county roads and all curves have a radius of 200 ft. or larger. The cross-section consists of a 28-ft. roadway with a 5-in. crown. Ditch slopes are 2 on 1 for a sloped length of 4 ft., and depths vary from 18 in. to 2 ft. The back slope is unusual in that it is 11 ft. long and made as flat as possible. The outside foot or so of the 60-ft. width is reserved for fences and telephone poles. The 11-ft.-wide back slopes on either side serve as roadways for farm machinery, most of which is heavy and equipped with lugged wheels. It is as important to the county that this machinery be transported from place to place as it is for trucks or automobiles to move, and therefore the extra expense involved in building and maintaining the back slope is justified; and the main road surface is saved from destruction.

FIG. 2—TYPICAL SANDED ROAD, RENO COUNTY
County Engineer Stacey, shown beside his car, is fortunate in having wide rights-of-way and a negligible grading problem on his 250-mile highway system.

Other factors dictate the use of a flat back slope. Weed cutting is made easier. In the winter, snow drifting is of major concern, and the flat back slope permits the snow to blow across the road rather than to lodge in the ditches.

Grading—Grading is a comparatively easy task, since the whole country is flat and no rock appears at the surface. The road cross-section, therefore, is easily formed with a blade grader. When hauls are short, balancing of cut and fill is done with a 75-cu.ft. rotary fresno pulled by a 10-ton crawler tractor. Longer hauls are made with wheel scrapers and teams, while the long-haul jobs utilize an elevating grader (also pulled by the 10-ton tractor) and as many bottom-dump wagons as necessary. For using the rotary fresno only two men are required, and on a recent 5-mile section all blade grading and fresno work was done for a cost of $300 per mile.

Surfacing Experiments—Road efficiency is measured by automobile speeds. According to Mr. Stacey, "Any road which will not permit a speed of 40 miles per hour with safety is given immediate attention." The soil in the county varies from a gumbo to blow sand, and an annual expenditure of $500 a mile on some sections for

FIG. 3—RENO COUNTY PROVIDES SEPARATE ROADS FOR FARM MACHINERY
Black slopes of ditches are made 11 ft. wide and nearly flat, to accommodate lugged-wheel machinery that would destroy the main road surface.

the past ten years has caused the engineer to experiment with numerous surfaces in order to reduce this maintenance charge. One of these experiments on a gumbo road utilized a sand-gravel mixture with a fineness modulus of 3.85. By periodically blading this into the road from a windrow placed along one side, a very solid and smooth surface was obtained. Constant maintenance was required, however. In an attempt to get a surface of better wearing quality and lower upkeep, a ½-mile section of sanded gumbo road has been treated with a 55 per cent slow-drying road oil with a pure asphaltic base. A mixed-base oil, such as that which comes from the Mid-Continent oilfields, was found not to be suitable, and a quick-drying oil with a higher percentage of asphalt made the surface too stiff. The 55 per cent oil seems to be of just the right composition, staying "alive" for the maximum length of time. On this gumbo road, which had a sand-clay crust about 3 in. thick, 0.9 gal. of oil per square yard was used in two applications, a month apart. The first application was placed on a blade-prepared surface. After the second application, coarse river sand in an amount of 35 lb. per square yard was spread by hand over the road. With the placing of the second application of asphalt, a bituminous sand mixture about ⅞ in. thick covered the road and has given a very satisfactory surface.

Two other mixed-in-place bituminous experimental

FIG. 4—SURVEYING PARTY'S TRUCK IN RENO COUNTY STORAGE YARD

sections were also placed last spring. One of these was a 2-mile section on which 1 gal. of the 55 per cent oil was applied in two applications, as on the first experiment. The third experimental section adjoins this 2-mile section and is 1 mile in length. The application in this instance was 1.15 gal. per square yard applied in two consecutive applications. This section has so far retained the best surface.

The latter two experimental sections are on a road soil that contains a minimum amount of binder. After grading, it will pack for a short time, but under traffic it develops into a typical blow-sand road, almost impossible to maintain. The mixed-in-place bituminous surface seems to have solved the problem of maintenance on this type of road in a very satisfactory manner. The cost of oil application, including the sanding, was $1,600

FIG. 5—CONSTRUCTING A MIXED-IN-PLACE BITUMINOUS SURFACE

Distributor has just passed, oiling one-half of the road. This is mixed by blade graders, and another oil application made. Note piles of coarse sand at left, which is spread over road by hand, following second oil application.

a mile for the 1-gal. application and $2,000 a mile for the 1.15-gal. application.

Maintenance—Maintenance is by the patrol system. There are 26 such sections averaging about 9 miles in length. Horsedrawn maintainers are used. The patrolmen rent houses near the center of their sections, numerous houses being available as a result of the development of power farming and the cultivation of a group of farms by one man. This same development has increased the traffic of farm machinery along the highways and is one reason for the use of the ditch back-slope roads.

The patrolmen also cut all weeds. In the fall the weeds are burned so as not to form obstruction to snow. Snow removal can usually be handled by the patrolmen, but where deep drifts occur the county engineer lends aid with snow plows and 10-ton tractors. Also, many miles of snow fences must be erected each year. These are of the wood vertical-slat type which can be rolled up for transporting or for storing.

The patrolmen are mostly experienced foremen. When construction work must be done on their sections, they hire local labor and run the grading gang, using county equipment. A typical outfit for this sort of work includes a 10-ton tractor, a 12-ft. blade grader, an elevating grader, a rotary fresno, wheeled scrapers, and bottom-dump wagons.

Bridge Practice—All streams, including the Arkansas River, are shallow and low banked. Usually they are quite wide. A creosoted piling bridge has, therefore, been developed as a standard, utilizing ship-lap for floor and head walls. All of the structure except the handrail is creosoted with a 12-lb. treatment. The bridges are made 24 ft. wide to accommodate combines and other farm machinery. Although fir and Southern pine cost about the same in Reno County, Southern pine is used because it has been found to take the creosoting treatment better. An important feature is the use of a 3-in. wearing surface of sand-clay on these bridges. This provides a smooth surface, protects the ship-lap floor and permits the patrolmen to grade across the bridge.

Concrete boxes are used for culverts where streams have a defined course. There are many drainage courses, however, which can be shifted at will, and for these concrete pipe or corrugated metal pipe are utilized. Concrete pipe is used above 18 in. in diameter, but only up to 30 in., because of the prevailing low road grades which reduce the cover over the culvert and therefore increase the effect of impact.

Expenditures—The county is spending $6,000 a month on its bridges and $9,000 to $10,000 a month on its roads. Most of these funds come from a general tax levy, although $32,000 is received from the state gas tax. The townships spend about $110,000 a year on their roads, $32,000 of which comes from the state gas tax. All township bridges of over 5-ft. span are built by the county. There are 18,000 ft. of bridges on township roads. The county also does the grading for the township at a specified rate per hour rental of the equipment.

No benefit district financing is used on highway work. As fast as possible land is being acquired to bring all corners to a 200-ft. radius. At the intersection of two 60-ft. highways this requires about an acre of land. It is the practice to pay twice the assessed valuation, and since the assessed valuation is about two-thirds of the market price, land has been acquired with a minimum of trouble.

Other County Work—All legal and private survey work in the county and towns, except Hutchinson, is done by the county engineer's office. The state fish and game department is considering placing a lake in the county, and the necessary surveys have been made by the county engineer. Plans have been prepared on a 20-square mile drainage district involving levee work, but this is held up pending decision on a larger drainage district in which two counties, Rice and Reno, are interested. The county engineer has made the survey for this larger district, about 100 square miles, and the benefit

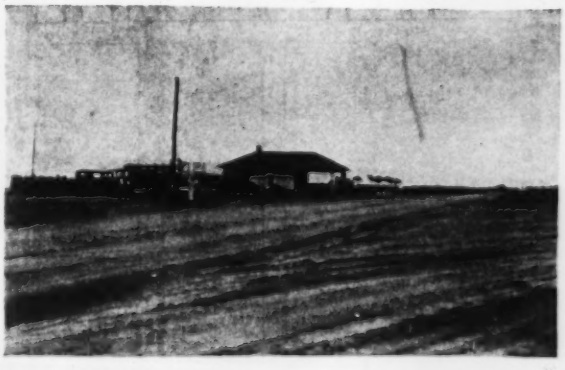


FIG. 6—AN ACRE OF INTERSECTION, WITH 200-FT. RADIUS CURVES, RENO COUNTY

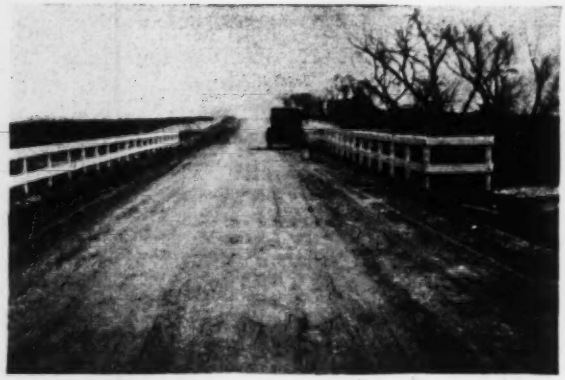


FIG. 7—RENO COUNTY BRIDGE WITH DIRT WEARING SURFACE

Besides protecting the wood deck of the bridge, this surface permits maintenance graders to cross without difficulty.

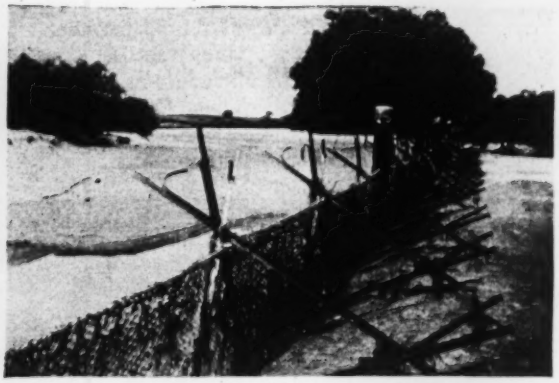


FIG. 8—CHICKEN-WIRE JETTIES GUARD BRIDGE ABUTMENTS FROM STREAM EROSION

Jetties similar to this are placed at right angles to all bridge abutments, on the upstream side. The accumulation of leaves and drift makes it an effective levee.

district is now being formed. The small drainage district will be included in the larger one, according to present plans.

Organization—A considerable organization is necessary to carry out this county work. Mr. Stacey has a field party of three men and a clerical force of two. There is a general superintendent in charge of construction and maintenance work and another man who acts as yard and machine shop superintendent. There are 26 patrolmen under the general superintendent. Four bridge gangs operate continuously, one on concrete culverts, one on creosoted bridges, one on small culverts and one on general repair work. Finally, there are four road construction gangs, each equipped with a 10-ton tractor. One of these concentrates on township work, one does all of the hedge and stump pulling in clearing corners, and two gangs are on straight county grading work.

A well-equipped yard is maintained. Creosoted timber, culvert pipe and 12,000 ft. of snow fence are kept in stock. In addition there is a house for the yard superintendent, garage for the seventeen cars and trucks, the latter of 1½- to 3-ton capacity, and a machine shop. Other items of equipment include a 7-S concrete mixer, two jetting pumps for piledriving and two sand pumps of 4- and 6-in. diameter. These latter are mounted on trailers

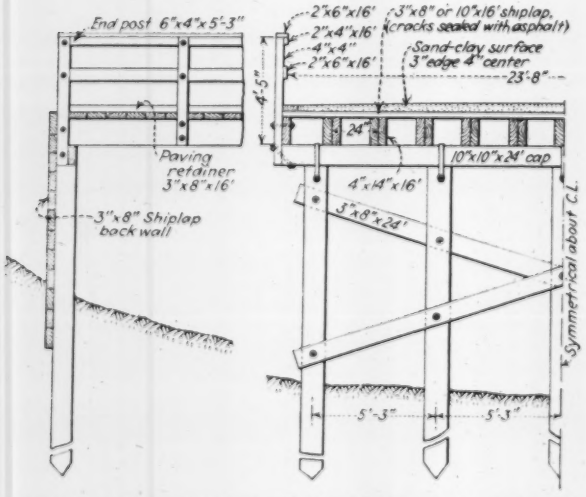


FIG. 9—DETAILS OF STANDARD CREOSOTED TIMBER BRIDGE, RENO COUNTY

and are used to secure aggregate and surfacing sand from the streams. Gravel pits are owned in various parts of the county. The largest dynamite magazine in the county is maintained in one of the near-by salt mines, and the county supplies most of the dynamite used privately or publicly in the county.

Metropolitan Highways in a Rural County

A suburban area gives rise to different engineering problems than does one with rural characteristics. When the suburban area is cultivated, it is usually in an intensive manner, as by truck farming and dairying. These, of course, require an all-weather road. When the suburban area is plotted and developed for city homes, the roadways must be hard surfaced, with curb and gutter cross-sections. A strictly rural area, on the other hand, can do with a surfaced road, smooth in dry weather and passable in wet weather.

Johnson County, Kan., on the eastern Kansas border, adjacent to Kansas City, Mo., is in the anomalous position of having all three types of territory and yet containing no city larger than Olathe, the county seat, with a population of 3,800, located 25 miles west of Kansas City. Furthermore, the suburban area of the county, which is adjacent to Kansas City, is comparatively small but contains 30 per cent of the population of 30,000 and 50 per cent of the assessed valuation of the county, which totals $55,000,000. The result has been that the bulk of road expenditures has been concentrated in this section of the county, except for the money that has been spent on state roads.

The county is approximately 25 miles square and is traversed by 1,200 miles of highway, of which 100 miles, including 32 miles of brick and 20 miles of concrete, is in the state system, 100 miles in the county system and the remainder in the township system. The county engineer's task of building state roads, supervising real estate developments in the metropolitan area and giving some measure of attention to the major part of his mileage, which is rural, has been a difficult one.

Metropolitan Roads—In spite of the fact that the bulk of direct tax money has been spent in the heavily populated northeast corner of the county, the amount of money has proved far from adequate for this territory and it has been necessary to resort to benefit districts. Fortunately, the principal real estate development organization, the J. C. Nichols Companies, is ably managed, so that the county has enjoyed good co-operation

and advice in dealing with the benefit districts. Both the Mission Hills and Indian Hills districts, high-class residential sections of Kansas City, are in this part of Johnson County.

Concrete pavement is used to a large extent, some with curb and gutter. A type which is giving splendid service consists of a 10-in. telford base with a 2-in. asphaltic concrete top. Both base and top are spread by hand, and a 10-ton tandem roller is used for compaction; 30 lb. of rock and ½ gal. of asphalt are applied per square yard. Cutback asphalt is also being used lately. The cost is $1,200 per mile for a pavement width of 30 ft.

New Work—S. P. Eberhart, the county engineer, expressed himself as elated over the new state law which relieves him of any responsibility for state highways. "Now I can do what I have never found time for before,"

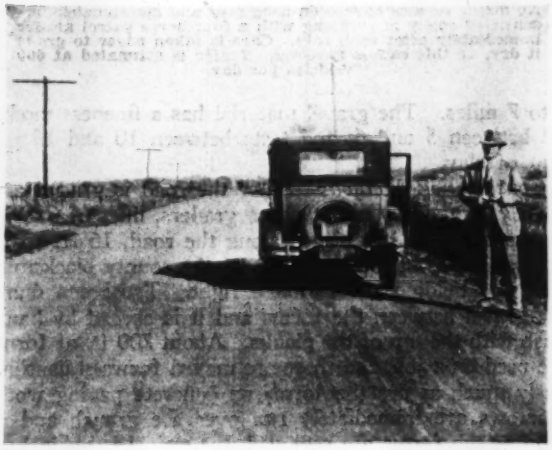


FIG. 10—SANDED-EARTH ROAD IN JOHNSON COUNTY, ONE OF THE BEST

S. P. Eberhart, county engineer, has recently let contracts for sanding 60 additional miles of his 100-mile system. After the first application, sand is strung along one side of the road and graded to the center in the course of periodic maintenance work.

he told the writer, "which is to provide the people of the rural sections with access to these main highways that we have built during the past five or six years. That, as I see it, is the county engineer's real job rather than being a sort of district engineer for the state highway department." Practically, he is starting from a new beginning. A few new culverts 28 ft. wide have been put in, but the county system contains no other improvement. This year's levy for roads is $45,000, and for bridges $55,000. In addition, there is available $20,000 from the state gasoline tax.

Sand or gravel surface roads are the solution for the county system. Very little widening will be attempted, the roads now averaging between 20 and 24 ft. Existing grades will be used as much as possible, with the bad places repaired by slip scraper work. By using this method, a sand surface can be provided for about $2,500 per mile; any standard grade, exclusive of surface, would cost $5,000 per mile in the rough terrain of the county. Benefit districts will be used on this work, but to a lesser extent than in the metropolitan district of the county.

Contracts let in October, 1929, for 60 miles of such surfaced roads provide a chat surface for about $2,000 per mile. Bids were requested on either sand or Joplin chat. Bonds were issued on the basis of applying 800 cu.yd. of sand per mile. This is more than will be

FIG. 11—CONSTRUCTING A TELFORD PAVEMENT IN JOHNSON COUNTY

Although the majority of Johnson County roads are strictly rural, much of the county engineer's work has been concentrated on this type of construction.

required the first year, but Mr. Eberhart believed it to be economical and good business sense to assure all of the necessary money for the completed project at one time. The plan is to apply 400 cu.yd. per mile the first year, 200 cu.yd. the second year and the final 200 cu.yd. in the third year. When the 60 miles is surfaced, there will remain only about 12 miles of the county system without some kind of a weatherproof surface.

Organization—In addition to the county engineer, there are two assistants in Johnson County, one in charge of construction and the other in charge of field parties. There are two grader outfits and three bridge crews, all used largely for maintenance. Other maintenance is done by patrols, mostly horse operated, although motor outfits operate out of Olathe. It has been found that two-man patrol crews, with a tractor and a towed grader, prove more economical than a one-man grader outfit.

Surfacing County Roads With Local Pit Gravel

A program of county road improvement involving grading to a wide cross-section followed by surfacing with local gravel is being carried out in Lyon County. Interesting methods of construction and a unique gravel

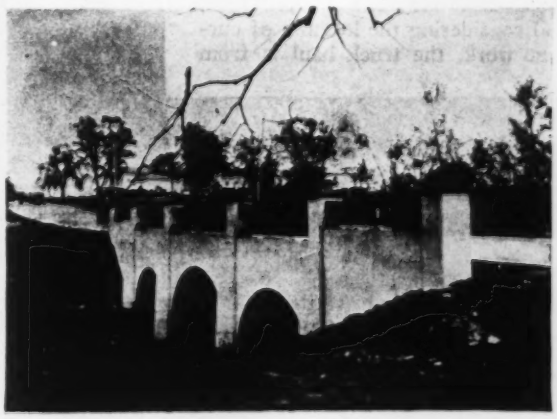


FIG. 12—A BENEFIT DISTRICT BRIDGE IN JOHNSON COUNTY

Telford road under construction in the background, adjacent to Indian Hills Country Club.

hauling contract with truck owners comprise phases of the program that may be of general applicability in other counties.

The topography of Lyon County is for the most part hilly, with numerous broad, flat plateaus. Its county seat and principal town is Emporia, which has a population of about 15,000. The remaining towns in the county are small and are situated in two lines, one along the northern and one along the southern boundary of the county. Thus the county road system, while it converges on Emporia in the main, is also laid out to serve the smaller market centers. County road activity, therefore, is spread rather evenly over the whole county. The county road system involves 200 miles of highway, of which 50 miles has been brought to standard gravel surface, under a plan developed by O. D. Henry, county engineer.

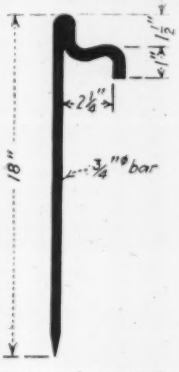


FIG. 14 — BLACKSMITH-MANUFACTURED STAKE FOR GRAVEL ROAD FORMS, LYON COUNTY

Since the state system passed out of county control, rapid progress has been made in surfacing the county system. Comparatively heavy grading usually precedes the gravel surfacing, inasmuch as it is paramount that the roads first be kept out of the mud. It has been found that by the use of a heavy blade grader and by using fresnos to take the graded earth directly from the blade economical results can be obtained. In one recent instance, 5,000 cu.yd. of earth was moved per mile at a cost of $700 per mile. Standard county roads vary in width from 28 to 32 ft. and are flanked by ditches 8 to 10 ft. wide in depths of about 3 ft. The ditches are made wide with a view to catching drifting snow in winter. All of the grading work, as well as the graveling which follows, is done by force account. Besides maintaining four grader crews, there are also four or five fresno grading gangs which supplement the grader crews on new construction.

For surfacing, a local gravel is used, which is found in pits fairly well distributed over the county. At the present time six pits are open, and considering the location of current work, the truck haul is from 1 to 7 miles. The gravel material has a fineness modulus between 5 and 6, and tests between 10 and 15 per cent of clay.

FIG. 15—GRAVEL ROAD IN LYON COUNTY, AFTER FIVE YEARS' SERVICE

No major repairs have been necessary and maintenance has consisted solely of scraping with a four-horse patrol grader immediately after each rain. Care is taken never to grade it dry, as this causes raveling. Traffic is estimated at 600 vehicles per day.

Construction Methods—After the road is graded and freshly scraped by maintenance graders, lines of 2x8-in. planks or forms are placed along the road, 16 ft. apart. Special stakes have been made by the county blacksmith shop for holding the forms upright. Truckmen dump the gravel between the forms and it is spread by hand, flush with the top of the planks. About 700 ft. of forms are used on a job, and these are moved forward continuously much as are the forms on concrete paving work. Harrows are immediately run over the gravel, and as soon as the forms are removed, the gravel is again harrowed and finally bladed with horsedrawn maintenance graders. This constitutes the total amount of construction work, and costs about 8c. per cubic yard of material. Traffic is relied upon to bring the road to final surface, which ordinarily is about 22 ft. wide, thicker at the middle than along the edges. Usually a windrow of dirt is pulled from the ditches and distributed along the edge of the roadway, thus keeping the gravel from being pushed off the crown.

The largest particles in the gravel are about ¾ in. in diameter, and these at first come to the top. However,

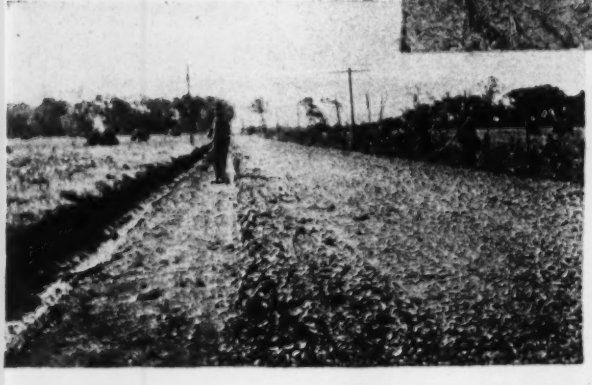


FIG. 13—BUILDING LOCAL PIT-GRAVEL ROADS IN LYON COUNTY

Center—Trucks dumping gravel between forms. Left—Gravel immediately after removal of forms and prior to its initial smoothing by a grader blade. Right—The completed gravel road.

under traffic they tend to work down and toward the edges so that the result is a hard compacted gravel surface of fairly uniform size of particles.

One of the important advantages of this type of road is that it improves with rain. In the opinion of Mr. Henry, a hard rain is the best maintenance possible for this type of road. Only after rains are these roads worked, and then they are ordinarily only dragged. The drag is a frame 16 ft. long made up of 3x12-in. timbers, the front timber shod with a grader blade, while straight blades are used on the rear cross-members. Occasionally this drag is supplemented by a 10-ft. tractor-hauled grader.

About 1,600 ft. of gravel can be applied in a day. The average cost of this gravel surfacing, including the grading, has been $2,000 per mile.

Gravel-Hauling Contracts—A unique agreement for obtaining gravel has been made with truck owners in the county—namely, a standing offer by the county engineer's office that anyone owning a truck can haul gravel to the road and present a bill for services rendered. No limit is placed on the number of loads hauled per day nor is it compulsory that any truck owner work exclusively for the county. County forces plow the gravel pits and remove the overburden where this is necessary, although it rarely is over 1 ft. thick. Each of the pits contains 5,000 to 20,000 cu.yd. of gravel. Most of them are located on hilltops and are thus favored with good drainage.

All of the truck drivers in the county are informed that they can haul gravel and thus fill in slack time. Many farmers also avail themselves of this means of extra remuneration. At the present time about 60 trucks are hauling every day. Payment is 15c. per cubic yard per mile, with 25c. paid for the first half-mile.

Reinforced Vitrified-Clay Pavement Slabs

VITRIFIED clay in a new form for highway paving is predicted in preliminary announcements from the laboratories of the school of mineral industries of the Pennsylvania State College. Prof. Joseph B. Shaw, head of the department of ceramics, and Myril C. Shaw have developed the principle by which the new material is to be made. Such laboratory work as can be performed on a small scale has been completed. Plans are under way for the construction of an experimental and commercial plant in which the larger details will be worked out. It is planned to go into commercial production as soon as equipment can be developed.

The advantages claimed for this process are that the material may be turned out in almost any size; that reinforcing iron may be introduced if desired; that a product comparable in strength to paving brick may be made from any grade of clay or shale, and that it may be manufactured cheaply. Fuel requirements will be no greater, and probably much less, than those of present processes. The approximate limits of size, as far as seen at present, will be about 8x20 ft.

All clays pass through varying degrees of fluidity during the vitrification process. If external pressure is applied at any time when clay is within this range of temperature, the clay particles will slip over one another and a dense product will be obtained. It has been found that thin slabs, 1 to 2 in. thick, will oxidize rapidly and when subjected to the forming pressure the joint between slabs is eliminated. It is possible therefore by dry pressing thin sections to heat them through the dehydration and oxidation periods in a few hours as compared with days that would be required for articles of great thickness under present methods of manufacture, and at the proper temperature press or roll the thin sections into a massive homogeneous block. It is also possible to reinforce these blocks by inserting reinforcing steel between the sections and pressing it in place. The steel does not deteriorate materially during annealing.

In carrying out this process the equipment and processes of the steel industry replace in large measure those of the present-day ceramic plant. The product receives its ultimate shape by pressing or rolling while the clay is in proper physical condition to respond to such treatment.

Massachusetts Places All Traffic Signals Under State Control

IN ACCORDANCE with the provisions of an act of the Massachusetts Legislature placing all street and highway signs and signals under the control of the state Department of Public Works, this department has recently issued a standard code for signal installation and operation which is intended to insure uniformity in the design, location and operation of such signals throughout the state. While the department actually erects the signs only on state highways and "ways leading thereto," it supervises all other signals, including those erected by municipalities, and must approve such installations before they can be legally effective. Uniformity is to be secured by refusing approval of installations which do not conform with the standard regulations.

While the standard signal code is based largely upon the report of the American Engineering Council committee on street traffic signs, signals and markings, there are a number of modifications based upon special conditions existing in Massachusetts. The most notable advance in practice is found in the regulation requiring certain minimum traffic to be proved by actual count before signals can be installed or operated. Furthermore, signals which are necessary during parts of the day may not be operated, except as flashing or warning signals, during periods when traffic is below the minimum requirement for a period of over one hour. As early morning traffic is light throughout the state, no stop and go signs can be operated between the hours of 11 p.m. and 7 a.m.

To justify signal installation at an intersection the Department of Public Works requires that traffic counts show a minimum vehicular traffic of 500 vehicles per hour, of which not less than 125 must use the minor streets of an intersection. Signals are also justified when pedestrian traffic is at least 250 per hour and vehicular traffic on the two intersecting streets is not less than 500 per hour. Signals will also be permitted at points where necessary to check excessive speeding, or at intersections where, although otherwise unjustified, signals will be operated as part of a co-ordinated system. The signals themselves must be of the three-lens type, showing green, amber and red, and each set can control one intersection only. The standard location prescribed is at the far right corner of each intersection, requiring four-post installation. Co-ordinated operation is required when two or more signals are less than 2,000 ft. apart, and simultaneous operation is permitted only if two signals are less than 500 ft. apart.

Borings Show Foundation Suitable for Golden Gate Bridge Piers

Preliminary Work Completed, Final Design Under Way on 4,200-Ft. Suspension Span—Court Decision Favors Project

WITH the completion of the contract for making test borings on the pier site of the proposed Golden Gate bridge, preliminary study of the project to build a 4,200-ft. suspension span across the entrance to San Francisco Bay nears completion. The results of the borings are satisfactory, and preparation of final plans and specifications is now under way. Progress to date on the project was reviewed in a report dated March 12, addressed to the board of directors of the Golden Gate Bridge and Highway District by Joseph B. Strauss, consulting engineer, Chicago, chief engineer of the district, and signed also by the three consultants, O. H. Ammann, Charles Derleth, Jr., and Leon S. Moisseiff. The following has been taken from that report.

The district, comprising the six counties of San Francisco, Marin, Sonoma, Napa, Del Norte and Mendocino, was formed under an act passed by the California Legislature in 1923. For some time progress was delayed by litigation based on legal grounds, primarily the objection of taxpayers to the proposed plan of financing. This litigation only recently was disposed of by the U. S. Supreme Court by dismissal of the protestants' petition.

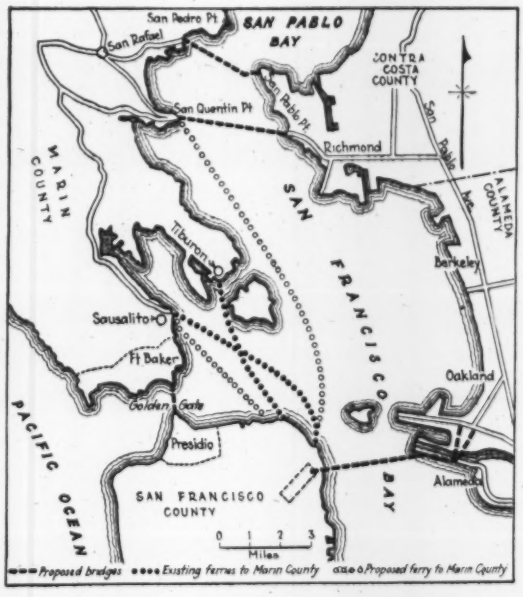
Final plans for the bridge are now being prepared for submission to the federal government for approval in accordance with the stipulation outlined by the War Department when the provisional permit was issued. Simultaneously preparation is being made for an election this fall to vote bonds in the amount of $30,000,000 to cover the cost of the structure. These bonds "do not increase the bonded indebtedness of any one of the counties included in the district, and the district as a whole merely loans its credit, the earnings from the bridge retiring the bonds. It is hoped to start work at the beginning of 1931 and to complete the bridge in 1936."

Test borings at the pier sites were begun Nov. 25, 1929, and completed Feb. 25, 1930. During this time three holes were sunk at the San Francisco anchorage site, six at the San Francisco pier site, four at the Marin pier site and three at the Marin anchorage site, the depth of penetration varying from 15 to 141 ft. in rock.

Borings on the San Francisco side had to be made in tidal currents the velocity of which at times reached 7 miles per hour. The work was completed according to agreement, however, by the E. J. Longyear Exploration Co., of Minneapolis, for the contract price of $29,640.

Borings showed that the Marin pier site is located on a compact greenstone or diabase. A projecting ledge of this formation at high-tide line made it economical to increase the length of the span 200 ft., making it 4,200 ft. in the clear, in order to take advantage of this projection and keep the pier above the waterline.

The San Francisco pier is to be located in water 55 to 65 ft. deep on a rock shelf which extends out some 200 ft. beyond the pier site before sloping sharply into deep water. The formation is a serpentine that has "suffered internal shearings, so that it now consists of an aggregate of ellipsoids or spheroids of strong rock embedded in a matrix of sheared rock of very small strength." However, a pressure test with a 20x20-in. post conducted on similar formation near this pier site at high-tide line showed the formation able to withstand a load of 33 tons per square foot, or more than double the maximum load to be imposed by the pier.



LOCATION OF GOLDEN GATE BRIDGE

The foundation material at both pier sites was pronounced "amply sufficient to support the piers" by Andrew C. Lawson, professor of mineralogy and geology, University of California, consulting geologist for the district.

Further study of the project has developed relatively few changes from the original plan. Main features of the design now proposed are as follows: main span 4,200 ft. clear; approach spans, 1,100 ft. each; total length of structure, 8,500 ft.; width from center to center of cables, 90 ft.; clearances above high water, 200 ft. at the piers and 225 ft. at center; cables, 36 in. in diameter, and towers, 760 ft. above water level. A normal suspension design instead of a combined suspension and cantilever design was adopted on final analysis because of the somewhat lower cost and easier erection.

In co-operation with the state highway commission, the approaches to the bridge have been located so as to connect trunk routes 101 and 102, providing direct access from San Francisco to the Redwood Highway and the Pacific Highway to the north.

Traffic studies made by Sydney W. Taylor, traffic engineer, based largely on traffic over automobile ferries now crossing the Golden Gate and counting on only a normal increase during the five-year construction period, lead to his conclusion that "traffic at the end of the first year of operation, disregarding the traffic stimulation produced by the bridge, is estimated to give a gross revenue sufficient to pay the interest on the total $30,000,000 bond issue as well as all operating costs for the year, repay the preliminary fund of $300,000 derived from the 3c. tax, and leave a substantial balance besides."

A more comprehensive report on details of the project as a whole is now being prepared by the consulting engineer and will be available when final designs are ready. Previous references to the project in its earlier stages have appeared in *Engineering News-Record* as follows: Jan. 25, 1923, p. 181; July 10, 1923, p. 86; May 29, 1924, p. 951; Jan. 15, 1925, p. 97; March 25, 1926, p. 504; Dec. 1, 1927, p. 863.

Excavations: Rights and Liabilities of Owners, Contractors and Adjoining Owners

An Interpretation and Explanation of Common and Statute Law Governing Liabilities of All Concerned in Excavations Affecting the Property of Others

By Nathan Young
Member New York Bar

Mr. Young is well qualified to discuss the important question of rights and liabilities of all concerned in excavation work, holding both civil engineering and law degrees, being a member of the New York Bar and having made a special study of contract and engineering law. —Editor.

ALMOST every construction job commences with an excavation. Many end in a lawsuit. The controversy frequently arises out of the violation by the excavator of the rights of neighboring landowners. The engineer who is in charge of the job will determine in the majority of cases whether his client, who may be either the owner or the contractor, will be precipitated into a lawsuit by the manner in which he prosecutes his work.

These lawsuits often involve heavy legal expenses, and sometimes substantial judgments against the owner or contractor or both. These the owner or contractor may avoid by the careful and intelligent observation on the part of the engineer of the rights of the adjoining owners. It is highly important, therefore, that the engineer know what the rights and liabilities of his client and those of the adjoining owners are.

Liabilities of Excavator

***Under Common Law*—The owner of adjacent land in its natural state (unburdened by a structure) is entitled to lateral support of his property. Courts have generally held that excavator using reasonable care and precaution is not responsible for damages to adjoining structures.**

***Under Statute Law (New York)*—In excavations more than 10 ft. in depth below curb, owner of land under excavation must underpin or protect adjacent structures. In excavations not exceeding 10 ft. in depth below curb, owners of adjacent structures must underpin or protect their own property.**

Common Law

We derive from the English law, on which our common law is largely based, a fundamental rule that the owner of land in its natural state—that is, unburdened by a superstructure—is entitled to the lateral support of his property. This is a right that goes with the land and may not under any circumstances be violated.

Thus, if A should excavate on his property and thereby cause the adjoining land in its natural condition to slide into the excavation, he is liable for any damages his neighbor may sustain thereby, regardless of whether or not he is guilty of negligence in excavating on his own land.

This is a simple legal proposition covering simple facts. Under modern conditions, however, particularly in crowded cities where almost every inch of ground is covered by a building, a very different problem arises.

An owner desiring to excavate on his own land finds himself bounded on both sides by buildings. Does the right to lateral support of land in its natural condition apply as well to the building with which it is encumbered? If so, the excavator will find himself burdened with a heavy duty, for in that event he becomes the guarantor of the safety of the adjoining buildings and must properly underpin or protect them to avoid any possible damage. The courts have been very reluctant to impose such an obligation on the excavator, although in some decisions they approach it closely.

On the other hand, does the existence of a building on the land of the adjoining owner abolish entirely his right to lateral support and permit the excavator to proceed with his excavation within the boundaries of his land, disregarding absolutely any possible damage his neighbor may sustain? In our very early decisions we find judicial opinion sustaining such procedure for the reason that one who erects a building on his land may not thereby limit his neighbor, who should desire to improve his land, in the use thereof.

As we go down the line of American decisions we find the courts gradually adopting a far more reasonable attitude. They have very wisely applied to these cases an old maxim of law *"Sic utere tuo ut alienum non laedas,"* which means, "So conduct yourself as not to cause another injury."

How far does this limit the excavator? What obligations does this impose upon him?

A familiar expression of the courts is that the excavator must be reasonably careful and prudent in the prosecution of his work. This does not mean that he must support the adjoining building, but is rather in the nature of a restraint against wanton and reckless conduct on the part of the excavator.

Assuming, now, that the excavator is careful and diligent in the prosecution of his work but the adjoining land, nevertheless, is damaged, is he liable therefor? His liability depends on whether the adjoining soil slides by reason of the excavation or by reason of the weight of the superstructure. In the former case, the decisions almost uniformly hold that the excavator is liable for the injury to the land, but not for the injury to the building. In the latter case, the excavator is liable for neither the damage to the land nor the damage to the superstructure.

Whether the adjoining land has subsided by reason of

the excavation or by reason of the weight of the superstructure is very often difficult to determine and sometimes cannot be satisfactorily decided because of expert but conflicting testimony of engineers. Failure of the excavator to exercise reasonable care and diligence makes him liable for all damage to the adjoining land and superstructure provided the caving in of the adjoining soil was caused by the excavation and not by the pressure of the superstructure—a situation, as stated before, often difficult to determine.

In the leading Michigan case of Gildersleeve against Hammond, decided in 1896, the court held that the jury in rendering a verdict against the excavator for damage to the adjoining land and building was justified in finding that the adjoining land fell by reason of the excavator's carelessness. The facts were as follows:

The plaintiff had erected on his land a building on a foundation which was 20 to 24 in. below grade. The wall of this structure was 4½ ft. from the line dividing the plaintiff's and defendant's lots. The defendant excavated to this division line about 7 or 8 ft. deep. The soil was a mixture mainly of sand and gravel. As the excavation proceeded downward, the adjoining soil between the division line and the building began to fall away from the foundation and into the excavation. This the excavator carried away as quickly as it fell into the foundation. The building, laid bare, caved in, carrying with it the wall and the entire building.

Rules Governing Liability

The court, in approving the verdict of the jury, suggested that the excavator in this case might have avoided the subsidence of the soil and the consequent damage to the building by excavating and building his wall in sections or by sheeting to keep the soil in place. The court formulated certain rules governing the liability of the excavator which in a general way cover the question very concisely and clearly. They are as follows:

1. While a landowner has the undoubted right to excavate close to the boundary line, he must take reasonable precautions to prevent his neighbor's soil from falling.
2. If he has taken such reasonable precautions and yet the soil falls from its own pressure, he is still liable for the injury to the land, but not for any injury to the superstructure.
3. If the pressure of the superstructure causes the land to fall, he is not liable for injury to either the land or the superstructure.
4. If he fails to take such reasonable precautions to protect his neighbor's soil and to preserve it in its natural state, he is liable for the injury to both the land and the superstructure, if the pressure of the superstructure did not cause the land to fall and it fell in consequence of the failure to take such reasonable precautions.

The next question that logically presents itself is, What is meant by reasonable prudence and care or reasonable precaution as the term is used by the court in the decision quoted above? This is a difficult question to answer, because the courts themselves, to whom we look for the solution, seem to be indefinite and uncertain about the matter.

In the recent case of Christensen against Mann, decided in Wisconsin in 1925, the court with reference to this matter said:

"The excavator cannot proceed with violent methods that will unnecessarily endanger his neighbor's building, . . . nor can he use antiquated or disapproved methods." But the court finally concludes, "Degree of care in each particular case depends largely upon the peculiar facts and circumstances and physical conditions in each case."

This is not entirely satisfactory as a guide, and requires examining the law as to particular acts necessary to absolve the excavator from a charge of negligence.

First and most important is the manner of making the excavation. The methods that have apparently received approval of the courts in numerous opinions are either to excavate and build the foundation wall in sections or to erect a shoring to keep the adjoining soil in place. These are precisely the methods suggested in the Michigan case quoted above.

Under our judicial decisions, the courts almost uniformly have refused to impose on the excavator the burden of underpinning the adjoining walls unless compelled to do so by statutes which are in force in some states.

Another element of prudence and care required of the excavator is to give timely warning to the neighboring landowner so that the latter may have an opportunity to protect his building, and the courts have upheld this requirement in a long line of decisions.

Knowledge on the part of the adjoining owner of the nature and extent of the excavation will excuse failure to give notice. But mere knowledge of the proposed excavation is not sufficient, for it does not necessarily imply that the adjoining owner is aware of the nature and extent of the excavation, which he must necessarily know in order properly to protect his building.

A further point of which the courts frequently speak and which must be borne in mind is that the giving of notice does not relieve the excavator of the duty to use reasonable care and diligence in making the excavation.

The excavator, having completed his excavation in a careful manner, has not yet entirely discharged his obligation, for in many cases damage has arisen out of the negligent maintenance of the excavation. In the early New York case of Austin against the Hudson River Railroad Co., decided in 1862, the excavator began operation in October or November, 1851. The evidence indicated that the excavation might have been completed in two or three weeks, but it was not completed until August, 1852. The excavation was carried to within 4 ft. of the plaintiff's warehouse, but was entirely confined to the land owned by the defendant. After the excavation was completed, work was suspended from time to time for considerable periods, leaving the plaintiff's building exposed without protection against water and ice. Piles were driven by the defendant after the excavation, but they were driven in such a manner as to crack the walls of the plaintiff's building. This, together with the action of the water in undermining the plaintiff's building, caused the wall to fall. The excavator was held liable for the negligent manner in which he maintained the excavation.

Condition of Adjoining Buildings

Another element that frequently enters into the question of the liability of the excavator is that of the condition of the adjoining building. It has happened that buildings injured by excavation of adjoining land were originally in a defective and damaged condition. What in such case is the liability of the excavator? In the case of Walker against Strosnider, decided in West Virginia in 1910, the court speaks of the liability for injury to defective buildings as follows:

Defectiveness or weakness in it does not justify negligence or reckless conduct on the part of the adjoining owner in altering the condition of his property or excuse him from liability for injury occasioned thereby. He is governed by the condition of the building as he finds it, and must conduct his operations

accordingly, for these conditions have been previously and rightfully made. To hold otherwise would give one adjoining owner the power to determine what sort of a building his neighbor should erect or in what state of repair he should keep it. Defects in the building may be such as to contribute to this injury in case of the removal of the adjoining earth, but the act of constructing it in an unskillful manner or allowing it to become defective would not be the proximate cause of the injury if it could be deemed negligence. There would be two causes of injury in such case, but the negligence of the excavator in failing to take reasonable precautions for the safety of the building, however defective it might be, would be the last cause of the injury, the nearest in time and therefore the proximate cause. Defectiveness of the injured building may mitigate the damages, but it does not bar the action for the injury.

Who Is Liable?

Our discussion has thus far covered the acts which create liability. Let us now look into the question as to who is liable for such acts.

It is usual for the owner to employ a contractor to make the excavation. The work may result in damage to the adjoining land and building. Assuming that the circumstances are such as to create liability for this damage, it is important to know whether the owner is liable or not. The contractor who caused the damage is primarily liable. Generally, if the owner hires a skillful and careful contractor, who agrees to perform the work in a workmanlike manner, and if the work can be performed without injury to the adjoining property and there are no defects in the plans, he is not liable for any injury due to the contractor's negligence.

Many cases, however, arise in which not all of these conditions are present. In such cases we find that the owner is liable for the damage. The opinion written by the court in the case of Walker against Strosnider, *supra*, quotes from other opinions the circumstances under which the owner becomes liable. Some of these are:

If the owner actually controls the manner of doing the work, he makes himself liable. If the injury results directly from the acts called for or rendered necessary by the contract and not from acts which are merely collateral to the contract, the owner is liable as if he himself had performed such acts. If the resulting injury was such as might have been anticipated as the probable consequence of his work directed to be done, the owner is liable whether he prescribed the mode of doing the work or not.

The owner is liable when the contract prescribes not only the thing to be done but also the manner in which the work is to be executed and the contractor does it in the manner so specified, for then the will of the owner controls, and he directs and orders the injurious and wrongful act, if it is wrongful.

Statutes Supersede Common Law

In many cities and states, ordinances and statutes have been enacted providing for stricter regulation of excavations and imposing heavier duties on excavators. This was a logical and natural development as a result of the erection of tall and costly buildings in very close proximity to one another in our crowded cities.

Most ordinances and statutes are very much similar to the New York City ordinances, which we shall here consider briefly. Paragraph 230 of the Building Code reads in part as follows:

1. *Safeguarding Generally*—Until provision for permanent support has been made, all excavations shall be properly guarded and protected so as to prevent the same from becoming dangerous to life or limb and shall be sheet piled, braced or shored, where necessary to prevent the adjoining earth from caving in, by the person causing the excavation to be made.

2. *When Retaining Wall Is Required*—When an excavation is made on any lot, and provision for the support of adjoining earth is not otherwise made in accordance with law, the person making such excavation or causing it to be made shall, at his own cost and expense, except as may be provided in Art. XI of this chapter or as hereinafter provided in this section, build a retaining wall to support the adjoining earth; and such retaining wall shall be carried to the height of the adjoining earth and be properly protected by coping.

Art. XI of the Building Code referred to deals with partition fences and walls, and retaining walls in general.

In all other respects these sections are self-explanatory. We now come to the more important clauses covering the protection of adjoining buildings. The ordinance continues to read:

3. *Support of Neighboring Walls.*

(*a*) *When Excavation Exceeds 10 Ft.*—Whenever an excavation is intended to be or shall be carried to the depth of more than 10 ft. below the curb, the person causing such excavation to be made shall at all times, if afforded the necessary license to enter upon the adjoining land, and not otherwise, at his own expense, preserve and protect from injury any wall, building or structure, the safety of which may be affected by said excavation, and support the same by proper foundations, whether the said wall, building or structure is down more or less than 10 ft. below the curb. If the necessary license is not accorded to the person making such excavation, then it shall be the duty of the owner refusing to grant such license to make such wall, building or structure safe, and to support the same by proper foundations, and when necessary for that purpose, such owner shall be permitted to enter upon the premises where such excavation is to be made.

(*b*) *When Excavation Does Not Exceed 10 Ft.*—If such excavation is not intended to be or shall not be carried to a depth of more than 10 ft. below the curb, the owner of any wall, building or structure, the safety of which may be affected by said excavation, shall preserve and protect the same from injury and support the same by proper foundations, and when necessary for that purpose shall be permitted to enter upon the premises where such excavation is to be made. In case such wall, building or structure, however, is so located that the curb to which it is properly referred is at a higher level than the curb to which the excavation is referred, such part of any necessary underpinning or foundation as may be due to the difference in curb level shall be made and maintained at the joint expense of the person causing excavation to be made and the owner of such wall, building or structure.

Since the enactment of this ordinance the judicial opinions in many New York cases have construed its meaning.

How Courts Have Construed Ordinance

The ordinance has been held to apply only to the owner of the land under excavation. The courts have construed the clause, "person causing such excavation to be made," in the ordinance, to mean the owner of the property excavated. In the case of Gordon against Hedden Construction Co., decided in 1915, the court held that contractors and subcontractors are not liable under this section of the Building Code.

The common law, as developed by the judicial decisions which we have discussed in detail, still applies to the contractor and subcontractor who are liable if, by reason of negligence on their part, the adjoining land and building are injured.

In several recent decisions the courts have construed the word "contiguous" in the ordinance to mean "near to" or "in close proximity to." The adjoining building therefore, which may be separated from the land excavated by a small strip of land, is nevertheless contiguous to the land excavated within the meaning of the ordinance.

Under the common law, the excavator was under no obligation to shore up or underpin the adjoining walls. Having received notice of the excavator's intent to excavate, the duty fell upon the owner of the adjoining building to underpin his own walls. The obligation of

the excavator was merely to exercise reasonable care and prudence in making the excavation. The statute has radically changed the law in this respect. When the excavation is intended to be or is actually carried down more than 10 ft. below the curb, the ordinance requires the owner of the land excavated, when permitted to do so, to support the adjoining walls at his own expense.

The filing of plans for an excavation more than 10 ft below the curb has been construed as the expression of an intention to carry the excavation more than 10 ft. down and is sufficient to create liability on the part of the owner of the land excavated in the event of damage to the adjoining building and failure to underpin the same, even though the excavation is actually 10 ft. or less deep. If the owner should decide to excavate 10 ft. or less, after having filed plans for an excavation of more than 10 ft., it is therefore advisable for him to file amended plans to that effect.

The reverse of this situation appears in the case of Rosenstock against Laue, decided in 1910, wherein the defendant entered into a contract with one Duffy to make an excavation on the defendant's land of 10 ft. below the curb. Duffy proceeded with the excavation and carried it to a depth lower than 10 ft. below the curb, injuring the plaintiff's adjoining wall, which the defendant had not supported. The defendant claimed that it was its intention to excavate only 10 ft. deep and if the excavation exceeded that depth the wrong was done by the contractor. The court held that the owner is liable if the excavation is carried to a depth of more than 10 ft. regardless of the fact that the work was done by the contractor.

In the case of Post against Kerwin, decided in 1909, the court held that liability of the person causing the excavation to be made, under this ordinance, for damage to an adjoining wall because of failure to underpin and properly protect it, is absolute and entirely independent of any question of negligence.

Modern conditions make the provisions of this ordinance very wise and salutary. It is quite obvious that in cities where structures involving a cost of millions of dollars each are erected, the law ought to place every possible reasonable safeguard about them. Such laws will doubtless in due time become universal in the United States. In those states, however, where such statutes have not yet been enacted, the common law still governs.

Value of Heat Treatment for Steel Rails

SOME essential features in the production of sound steel for rails and some high qualities obtainable by heat treatment of rails are presented as conclusions in a paper by W. C. Cushing, engineer of standards, Pennsylvania Railroad, and forming a supplement to the 1930 report of the rail committee of the American Railway Engineering Association. They are as follows:

Sound Steel—In order to obtain sound steel for rails there must be such alterations and improvements in the various stages of manufacture as will: (1) eliminate to the greatest degree possible slag and foreign inclusions, and disseminate to the widest and minutest extent the minor quantity which it may be difficult to remove; (2) reduce to the minimum the incompletion of chemical reactions in fluid mixing and segregation of the elements during cooling in the molds, a promising method being by the use of molds with the large area at the top while provision is made for governing and equalizing the freezing of the metal by a suitable arrangement for retaining the heat in the upper part of the ingot.

Mechanical Strength—With sound and clean metal at the start, it has been demonstrated in these investigations that rails having the following properties can be commercially manufactured by the use of the operations of heat treatment: (1) a higher elastic limit by 60 per cent, which is greater than has been afforded by any alloy or special mode of manufacture experimented with in 20 different trials by this company in the last 30 years; (2) a higher ultimate strength by 25 per cent, with proportionate increase in the engineering endurance limit, which is the measure of the fatigue limit in useful service; (3) an elongation increased by 35 per cent and a greater reduction of area by 140 per cent when the steel is clean and non-segregated, but which can be deprived of its ductility to the extent of being no better than non-heat-treated steel if there be large slag streaks and inclusions remaining; (4) a superior hardness which has ranged in amount between 20 to 36 per cent, the significance of which is greater resistance to deformation and abrasive wear from train wheels.

Lath Trickling Filters Recommended for Treating Dairy Wastes

TREATMENT of dairy wastes by passage through lath trickling filters is preferable to chemical treatment, according to studies by E. W. Steel and P. J. A. Zeller, reported in Bulletin 38, Texas Engineering Experiment Station, College Station, Tex. The filter was 2 ft. square, composed of ordinary building laths placed 1¼ in. apart, alternate layers at right angles to each other, arranged in five tiers each 1 ft. deep, with a 4-in. space between tiers for convenience in sampling the sewage. For the filter tests 1 per cent solutions of whole milk were used; for the chemical tests the solutions were 0.5, 1 and 2 per cent. A summary of the conclusions follows:

1. Wherever possible a trickling filter rather than chemical methods should be used to treat dairy wastes. The advantages of the former method are:

(*a*) No preliminary treatment is needed except grit removal. (*b*) Sludge and scum disposal is not a problem. (*c*) A better effluent is obtained. (*d*) Slight treatment can be given to prepare the waste for discharge into city sewers. (*e*) A filter is more adaptable to fluctuations in the strength of the waste than is the chemical method. (*f*) Skilled operation is not required. (*g*) Operating cost will be low.

2. A trickling filter 5 ft. deep operating at a rate of 1.5 million gallons per acre per day or a filter 6 ft. deep operating at a 2-m.g.d. rate will produce a satisfactory effluent in the treatment of ordinary dairy waste (not including whey from cheese factories). At the 1.5 rate a filter 3 ft. deep will give sufficient treatment for some purposes. (Note: These rates are based upon 24 hours' operation per day. If the waste is discharged during twelve hours only, the area-dosage relationship must be changed accordingly.)

3. Sulphuric acid, alum, ferric chloride and ferrous sulphate are of value (approximately in the order named) in precipitating milk solids. With proper operation this method should produce an effluent suitable for discharging into streams or upon land without nuisance and without the necessity of chlorination. Sludge and scum will be a troublesome byproduct, although that resulting from the sulphuric acid treatment could probably be used for feeding to hogs or chickens.

Chicago Concrete Building Presents Difficult Foundation Problems

Proximity to River Introduces Complications— Concrete Bents Used for Part of Roof— Hipped-Roof Skylight

By S. E. Berkenbilt
Architectural Engineer, Chicago

DIFFICULTIES in pile and concrete foundation work were the main features of interest in the construction of the new office or administration building for Montgomery Ward & Company, at Chicago. In the structural design there are novel details in roof and skylight framing. Furthermore, this is an example of large buildings, with architectural treatment, in which the structural concrete forms the main portion of the exposed exterior surface. Unfavorable conditions affecting the construction work included heavy street traffic, congested at times by the opening of a bascule bridge, together with limited accessibility of site and restricted space for storage of material. In the view of the building as practically completed (Fig. 1) the street at the right rises to the Chicago River bridge and is crossed by a railroad whose right-of-way parallels the longer side of the building.

The west side of the site, 363 ft., fronts on the north branch of the Chicago River (Fig. 3). Its north side has 160 ft. frontage on Chicago Ave., which is only 50 ft. wide between curbs, has a grade up to the bridge and carries a double-track street-car line. For 48 ft. this side is adjacent to the bridge abutment. The east side adjoins the right-of-way of the Chicago, Milwaukee, St. Paul & Pacific Railroad. For construction work, the site was accessible only from the south, and a 35-ft. alley left at this end of the building was the only space available for the storage of materials and supplies. The building has eight stories and basement, with a tunnel under Chicago Ave. to connect with the basement of the company's existing warehouse building. Although the new building is intended for stores and office use, its design was made heavy enough to permit its use for light manufacturing purposes. To insure ample light and ventilation the stories are of rather unusual height, being 16 ft. from floor to floor in the first five stories and 12 ft. 6 in. in the upper stories.

Foundations and Footings—Wood piles driven in clay to hardpan and cut off 12 in. below water level form the foundations for the column footings. On the river side, where the building runs along the dock for a considerable distance, a mat foundation is built and is tied back to the interior row of columns, except where the building line deviates far enough from the dock to allow of independent footings. A mat foundation carrying four columns is also built at the northwest corner alongside the bridge abutment, where the footing is bounded on two sides by lot lines. At the northwest corner, with a tower 70 ft. high above the main roof, a combined footing was adopted in order to limit projections into the street and railway property. Fig. 3 shows the construction in its earlier stages. To maintain the dock line as required by the city, the present dock timbers and piles are anchored to the new building in such a way as to permit of future

FIG. 1—CONCRETE OFFICE BUILDING, CHICAGO
Clark St. in front. Railway right-of-way on left. Elevated tower for gate operator at crossing obscures the view. Concrete forms main portion of exposed surface.

replacement with a concrete bulkhead. This was accomplished by means of ties to an interior row of colums, the continuous concrete footing under the basement wall affording an anchorage for bolting the waling pieces behind the sheathing.

A sidewalk vault extending to the curb line was built along Chicago Ave., thus extending the basement floor to the edge of an old rubblestone curb wall having a battered back (see Fig. 5). To gain additional space, the toe of this wall was trimmed off sufficiently to allow a new concrete curb wall to be constructed. This method eliminated expensive shoring operations which otherwise would have been required and at the same time added considerable space to the basement. On the east side an easement was secured from the railroad company allowing a projection of 4 ft. for the foundation work. It was necessary, however, to design the basement walls for the superimposed load of locomotives on tracks only 5 ft. from the building line. Consideration was also given to the probability of future track elevation, which would call for independent bents under the tracks and resting on proper footings.

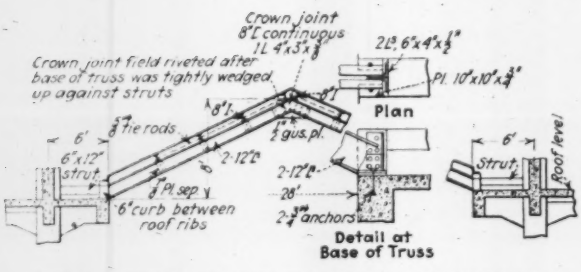


FIG. 2—HIPPED SKYLIGHT GIVES UNOBSTRUCTED LIGHT

Pile Foundation Difficulties—A test pile indicated that 55-ft. piles would be sufficient, but at some points where the ground was very soft it was necessary to use 60-ft. piles. Piledriving was started at the east or railroad side of the lot and continued toward the river, two piledrivers working in two sections. A noteworthy feature was the irregularity of penetration of piles in a given cluster. This was particularly noted in the more yielding soil at the east end. A close record of the penetration of each pile was kept and the number of piles in a footing was increased where necessary to give the designed loading, the pile cap being adapted to this final number and position of piles.

In driving the piles, complications arose because of large numbers of old anchor piles in rows in the center of the lot, having long tie-rods to the piles and waling timbers of the dock wall. In some instances the new piles were driven so as not to disturb the dock anchorage, the tie-rods being then embedded in the footing. Where the new piledriving had moved the old piles out of line and loosened the anchorage, the tie-rods were fastened to the new piles by cables and were drawn taut before being concreted. A similar condition was met at the river side, where an outer row of dock piles had to be incorporated in the new footings.

Proximity of the river during excavation and concreting called for careful designing of the foundations. A rich 3,000-lb. concrete was used for the pile caps and most of the combined footings, making them as shallow as practicable and keeping the bottom of concrete 16 in. below water level wherever possible. This method helped the handling of water during construction very considerably and enabled simple methods of sheeting to take care of conditions which otherwise would have required expensive steel sheetpiling at the riverfront.

A difficult condition was encountered where the existing dock sheeting was about 18 in. from the outer edge of the new piles. Here a double row of sheeting was driven by hand, parallel to the dock, the space inclosed being filled with puddled clay. Pumps continually at work kept the pits practically dry behind this cofferdam while the footings were concreted. But as the work approached the northwest corner this method proved inadequate, due principally to the rise of water level in the Chicago River. In the last week of April, 1929, the river was rising continually; this made it impossible to keep the cofferdam clear, as the water would break through and under the sheeting and no amount of pumping would remedy the situation. A portion of the continuous mat under the west wall was put in partly under water. With three lines of sheeting at the water line and five pumps continually at work, it was possible to keep the water at the bottom of the reinforcing bars. Concreting was begun at the outer end of the footing, practically in the dry, and was advanced toward the river, diverting the water flow toward the outer edge of the forms. Close watch was kept of the discharge of the pumps and when the presence of cement was apparent the pumps were stopped, almost instantly establishing the normal water level. The rest of the footing was then concreted under water.

On May 2 the river level had risen 16 in. above normal, creating a 3½-ft. head at the bottom of the concrete mat at the bridge abutment. Steel sheetpiling 30 ft. long was then driven outside of the dock from the bridge abutment, turning into the bank at both ends. Only a little pumping was necessary to keep the excavation dry, and the mat was readily concreted in place.

Building Design—Floor construction is of the flat-slab type, with drop panels and column capitals, and is designed for 150-lb. live load. Beam and slab construction is introduced where openings or long spans are required. Over the main entrance lobby a 34-in. steel box girder 20 ft. long supports an intermediate column extending from the second floor to the roof. An inner court starts at the sixth floor and large skylights over the fifth floor are carried on steel rafter frames without bottom chords, the rafters being supported on concrete cantilever beams projecting into the court at each column bent, as shown by Fig. 2. The elimination of trusses to support these

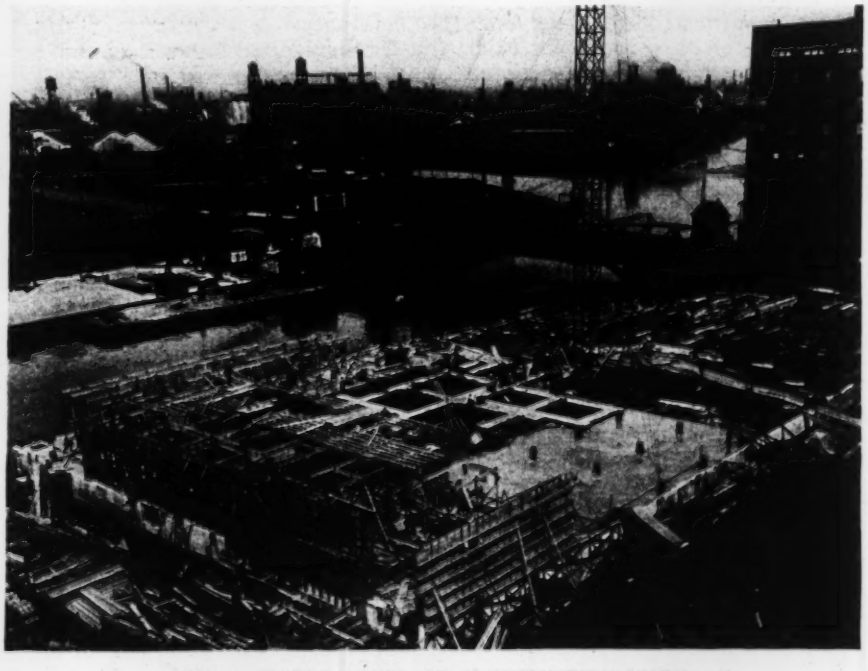


FIG. 3—EARLY STAGE OF CONSTRUCTION WORK
Alley at left is the only storage space. Site bounded on three sides by river, railroad and elevated street.

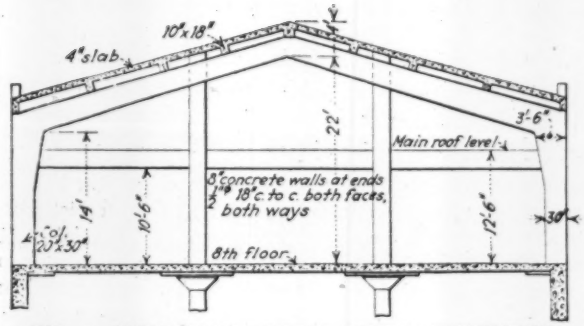


FIG. 4—RIGID-FRAME BENTS CARRY AUDITORIUM ROOF

skylights resulted in a continuous unobstructed hipped roof, giving abundance of light.

For an auditorium 60 ft. square on the eighth floor, overlooking the river, the usual columns were eliminated, and a high ceiling was effected by means of reinforced-concrete hipped girders or rigid-frame bents rising 22 ft. above the floor in the center, as shown by Fig. 4. An arched ceiling treatment follows closely the outline of these concrete girders. On the main roof is provision for recreation activities, including a garden, a stage, and space for horseshoe throwing, ball games and a golf putting course.

Exterior Concrete Finish—In all the outer walls and spandrels the exposed surfaces are of reinforced concrete, except that cast stone is used for the first-story facing and for decorative inserts above. To insure good appearance, great care was exercised in both the design and the construction of all exterior walls and piers. A comprehensive system of temperature reinforcement covering the entire surface, combined with careful distribution of steel for carrying loads and for rigidity, was provided on the plans. Continuity of connections between columns, beams and spandrels was detailed at each floor level.

All exterior column and spandrel forms were lined with $\frac{1}{8}$-in. wood-fiber board, fitted with butt joints and tacked to the wooden forms. The bottom joints of the forms were thoroughly calked with oakum to prevent leakage. The vertical sides of ornamental breaks of exterior columns were slightly beveled to assist in stripping the forms without injury to the concrete. In all concrete for exterior work, 3 per cent of a composition was added to insure good workability. Water-cement ratio and allowance for moisture content in the sand were rigidly enforced. Concrete deposited in the forms was well worked and rodded to insure a homogeneous mass. After the concrete had set, the entire exterior surface was given two coats of waterproofing of a light buff color for the vertical piers and mullions, and light green for the spandrels.

Subway to Old Building—The construction of the subway or tunnel under Chicago Ave. (Fig. 5) involved careful planning. There is a 7-ft. water-works shaft directly east of the bridge abutment and connected to a water tunnel under the river. A 24-in. water main leading into this shaft was about 8½ ft. below street grade and ran parallel to the curb. A 48-in. brick sewer about 13 ft. below grade runs approximately in the center of the street. Track construction for the street-car line required a minimum depth of 24 in. for ties and ballast, while telephone ducts ran diagonally about 4½ ft. below grade. As the floor line of the subway was fixed at the basement level, the subway was located near the water shaft, so as to gain additional headroom due to the rising grade of the street. The floor was sloped sufficiently to cover the sewer, while the water main was siphoned below the floor by means of long elbow fittings. The projection of the telephone ducts 5 to 10 in. inside the lining made it necessary to design the roof to carry the load of these ducts.

In the design of the subway (8x14 ft. inside dimensions), provision was made for 3-in. sheeting to be driven at the neat lines and serving as outside forms for the

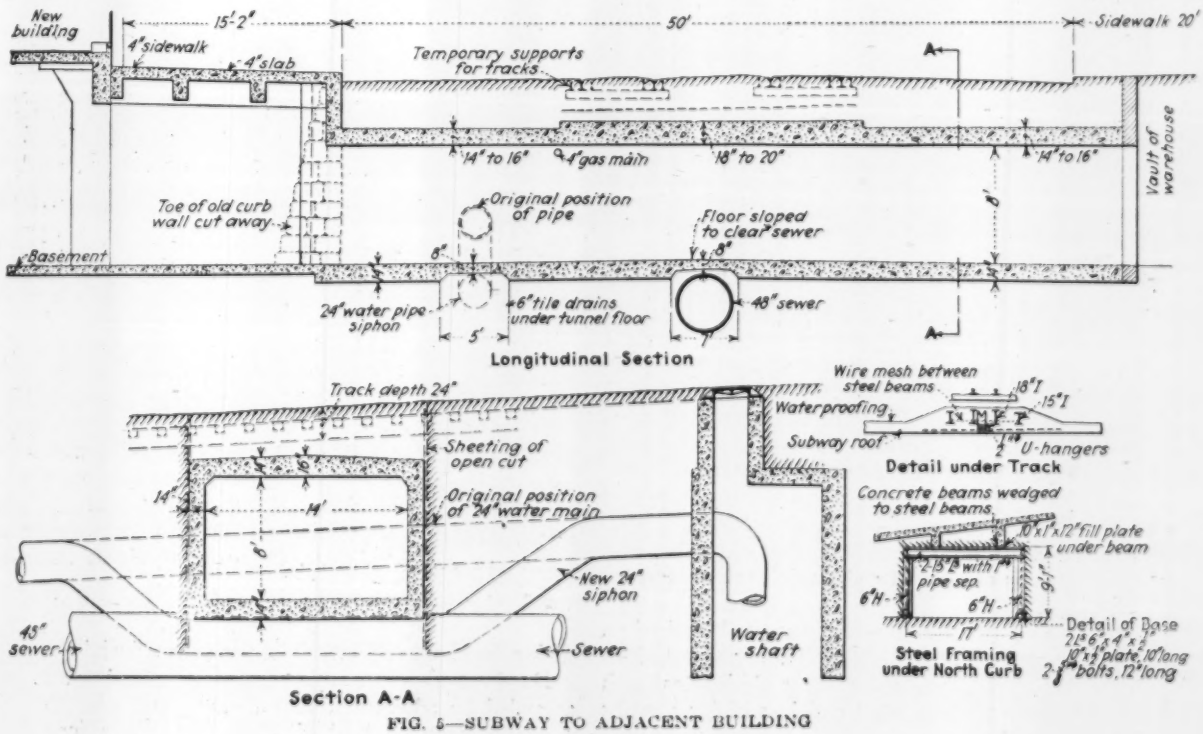


FIG. 5—SUBWAY TO ADJACENT BUILDING

concrete lining. Half of the street was occupied at one time and construction carried on in open cut. For temporary support of the car tracks, two heavy rails spanned the cut and supported the track rails by means of U-bolts passing under the wood ties. This half of the subway was completed and the roadway restored before beginning construction on the other half, quick-setting cement being used in the concrete base of the paving. This construction work was so well planned and was carried out so rapidly that there was very little interference with traffic.

Engineers and Contractors—The design and construction of this building was done by the construction department of Montgomery Ward & Company, under W. H. McCaully, construction engineer. Frank J. Poschenreiter was architectural designer. The Wells Brothers Construction Company was the general contractor, with E. J. Wheeler as superintendent. The writer was structural engineer in charge of design and construction. Rapid progress was made, the entire concrete work, from footings to roof, being done in four months, including a week's delay due to strike of the ironworkers in June.

The Steel and Iron Amendment to New York City's Building Code

EARLY in 1929 the Merchants Association of New York, through its standing committee on building laws and regulations, began the preparation of a draft revision of the building code which had last been amended in 1915. Approximately a dozen subcommittees made up of leading engineers and architects of the city did the actual work, submitting their reports in December, 1929. The committee on minimum loads and on structural steel and iron was one of these. Some of its suggested changes were incorporated in an emergency bill for early consideration. The Mayor signed the bill on March 25 and it immediately became effective as an amendment to the code. Although the provisions of the amendment are similar to those which have been adopted in the past year or two in numerous other cities, this particular amendment exemplifies the most advanced thinking in the field of structural steel design so well that it is presented here in almost complete form. —EDITOR.

THE FIRST of several amendments to New York City's building code, which became effective two weeks ago, affects principally the load and stress requirements for steel frame structures. The only exception to this is an increase in allowable working stresses for steel reinforcement in concrete structures. Among the more important provisions of the "steel and iron" amendment are: the increase to an 18,000 lb. unit stress; the recognition of alloy steels; the recognition of the strength added to beams by stone concrete incasement; the increase in permissible live loads, with types of structures affected more clearly defined; a new wind pressure clause requiring the use of a 20 lb. per square foot pressure from the top of a tall building down to a plane 100 ft. above the base. In the following abstract of the amendment the sections of the old code which are superseded are also given.

Kinds of Steel—In the old code structural steel of an ultimate strength of 55,000/65,000 lb. per square inch was specified. The new amendment designates such steel as *medium* structural steel and in addition permits special steels in the form of structural nickel and structural silicon with the following stipulations: (*a*) Silicon steel $\frac{7}{8}$ in. and under in thickness and nickel steel $\frac{1}{2}$ in. and under in thickness may be subpunched and reamed, or drilled from the solid, and if over that thickness shall be drilled from the solid. All gusset plates shall have the edges planed to allow inspection. (*b*) Special steels shall be inspected and accepted by an inspection bureau of known reputation, and an affidavit to this effect filed with the superintendent of buildings. (*c*) Special steel shall be kept segregated both at the mill and in the shop and shall be clearly marked so as to be distinguished in the field.

Working Stresses—The following paragraphs on working stresses are quoted direct. New data are in italics, unchanged in roman and old data superseded are inclosed in brackets:

(*a*) Working stresses in compression:

Rolled steel	.....	[16,000]	*18,000*
Cast steel	.....	16,000	.....
Cast iron	.....	16,000	.....
		Double Shear	*Single Shear*
Steel pins in bearing	[24,000]	*30,000*	*24,000*
Steel rivets, shop or power driven, in bearing	[24,000]	*30,000*	*24,000*
Steel field rivets, hand driven, in bearing	[16,000]	*20,000*	*16,000*
[Steel field bolts, in bearing	12,000]	.....	.....
Turned steel bolts in reamed holes	.....	*30,000*	*24,000*
Unfinished steel bolts	.....	*20,000*	*16,000*

On expansion rollers per linear inch 600 times the diameter of the roller in inches.

(*b*) Working stresses in tension:

Rolled steel	[16,000]	*18,000*	.....
Cast steel	16,000	.....	.....
Cast iron	3,000	.....	.....

(*c*) Working stresses in shear:

[Steel web plates	10,000]	.....	.....
On the gross area of the webs of beams and girders, where h, the height between flanges in inches, is not more than 60 times t, the thickness of web in inches	*12,000*	.....	.....
Steel pins and shop or power-driven rivets	[12,000]	*13,500*	.....
Steel field rivets, hand driven	[8,000]	*10,000*	.....
[Steel field bolts	7,000]	.....	.....
Turned steel bolts in reamed holes with a clearance of not more than 1/50 of an inch	*13,500*	.....	.....
Unfinished steel bolts	*10,000*	.....	.....
Cast iron	3,000	.....	.....

(*d*) Working stresses in bending, extreme fiber:

[Rolled steel beams and riveted steel beams	16,000]	.....	.....
[Rolled steel pins, rivets or bolts	20,000]	.....	.....
On extreme fibers of rolled shapes, and built up sections, net section, if lateral deflection is prevented	*18,000*	.....	.....

When the unsupported length in inches, L, exceeds fifteen times b, the width of the compression flange in inches, the stress in pounds per square inch in the latter shall not exceed

$$20{,}000 / \left(1 + \frac{L^2}{2{,}000\ b^2}\right)$$

The laterally unsupported length of beams and girders shall not exceed 40 times b, the width of the compression flange.

On extreme fibers of rolled beams with stone concrete haunches, and supporting a stone concrete slab on each side having no openings adjacent to the beam, provided the top of the beam is at least 1½ in. below the top and at least 2 in. above the bottom of the slab, and the concrete is mixed in the proportions of one part cement to at most 5½ parts of separate volumes of fine and coarse aggregates, measured dry, with at most 7½ gal. of water per sack of cement *20,000*

Steel pins, when the forces are assumed as acting at the center of gravity of the pieces	*27,000*
Cast iron, compression side	16,000
Cast iron, tension side	3,000

For special steels unit tensile stress shall not exceed 30 per cent of the minimum ultimate strength and other stresses may be increased proportionately.

Working Stresses in Columns—Under the old code working stresses for columns were tabulated for each l/r value from 120 to 10. Thus with an l/r of 120, working stress was 7,600 lb. per square inch; with l/r of 110, stress was 8,300, increasing as l/r decreased until with an l/r of 10, the working stress requirement was 15,300 lb. per square inch. This tabulation is superseded by the following in the new amendment: "On the gross section of rolled columns, the working stress shall be

$$18{,}000 \Big/ \left(1 + \frac{l^2}{18{,}000\ r^2}\right)$$

with a maximum of 15,000 lb. per square inch."

Dead Load—The code section on dead load was amended by adding a clause to the effect that "a uniformly distributed load of 20 lb. per square foot shall

be added to the dead loads of floors in office and public buildings, where partitions are not definitely located in the design, and in other buildings subject to shifting of partitions without reference to arrangement of floor framing."

Floor Loads—Under the old code floors were required to be designed to carry not less than the following live loads per square foot of area:

Forty pounds for residence purposes.

One hundred pounds for places of assembly or public purpose, except that for classrooms of schools or other places of instruction, the floor used need not be designed for more than 75 lb.

One hundred twenty pounds for any other purpose, except that the floors of offices need not be designed for more than 60 lb.

These old floor load stipulations are superseded by the following:

"Residences and Sleeping Quarters—For private dwellings, tenements and lodging houses, bedroom floors in hotels and clubhouses, private and wardroom floors in hospitals, dormitories and for similar occupancies, including corridors, the minimum live load shall be taken as 40 lb. per square foot uniformly distributed.

"Office Space—For office floors, including corridors, the minimum live load shall be taken as 50 lb. per square foot. Provision shall be made for a load of 2,000 lb. placed upon a space 2½ ft. square, whenever this load upon an otherwise unloaded floor would produce stresses greater than the 50 lb. distributed load.

"Places of Assembly Other Than Theaters and Halls—For classrooms with fixed seats, including aisles and passageways, between seats; churches with fixed seats; reading rooms; museums, and art galleries, the minimum live load shall be taken as 60 lb. per square foot.

"Theaters and Assembly Halls—For the seating space in structures with fixed seats, including the aisles and passageways between seats, excepting as provided in 'Panic Loads' below, the minimum live load shall be 75 lb. per square foot.

"Panic Loads—For aisles, corridors not otherwise provided for above, lobbies, public spaces in hotels and public buildings, assembly halls without fixed seats, theater stages, theater balconies and balconies in assembly halls, skating rinks, grandstands, gymnasiums, restaurants, dance halls, dining rooms, lodge rooms, laboratories in school and college buildings, stairways, fire escapes and exit passageways, and other spaces where crowds of people are likely to assemble, the minimum live load shall be taken as 100 lb. per square foot.

"Industrial or Commercial Occupancies—The following loads in pounds per square foot shall be taken as the minimum live loads permissible:

"(1) Floors for display and sale of light merchandise and where incidental factory work does not utilize more than 25 per cent of the floor area	75
"(2) Factory work, wholesale stores, storage and stock rooms and libraries	120
"(3) Stables	75
"(4) Garages for pleasure cars only	75
"(5) Garages for all other types of vehicles:	
For floor construction	175
For beams, columns and girders	120

"The design of floors for such garages shall also make provision for the heaviest concentrated loads to which the floors may be subjected, but in all cases these loads shall be assumed as at least 12,000 lb. concentrated at any point on a beam or girder.

"(6) Trucking spaces within the limits of the building	300

"The design of floors for such trucking shall also make provision for the heaviest concentrated loads; these loads to be assumed as at least 24,000 lb. concentrated at any point on a beam or girder."

Continuity was recognized in the new amendment to the extent that "in the design of continuous floors or rigid frames, a load distribution shall be assumed which produces the maximum stress in the member under consideration."

Loads on Vertical Supports—The paragraph under this heading in the old code read as follows: "Every column, post or other vertical support shall be of sufficient strength to bear safely the combined live and dead loads of such portions of each and every floor as depend upon it for support, except that in buildings more than five stories in height the live load on the floor next below the top floor may be assumed as 95 per cent of the allowable live load, on the next lower floor at 90 per cent, and on each succeeding lower floor at correspondingly decreasing percentages, provided that in no case shall less than 50 per cent of the allowable live loads be assumed."

This paragraph is superseded by the following: "Reduction of Live Loads—In buildings intended for storage purposes and in buildings less than five stories high, all columns, piers or walls, foundations, trusses and girders shall be designed for the full assumed live load. In buildings intended for other uses and buildings five or more stories high, the assumed live load used may be as follows: 100 per cent of the live load on the roof; 85 per cent of the live load on the top floor; 80 per cent of the live load on the next floor below; 75 per cent of the live load on the next floor below, etc., provided that at least 50 per cent of the live load shall be assumed.

"Girders, except in roofs, and as specified in the following paragraph, carrying a design floor load the equivalent of 200 sq.ft. or more of floor area may be designed for 85 per cent of the specified live loads.

"In designing trusses and girders which support columns and for determining the area of footings, the full dead loads, plus the live loads, shall be taken with reductions figured as permitted above."

Wind Pressure—In the old code three paragraphs referred to wind pressure as follows:

"All buildings over 150 ft. in height and all buildings or parts of buildings in which the height is more than four times the minimum horizontal dimension shall be designed to resist a horizontal wind pressure of 30 lb. per square foot of exposed surface measured from the ground to the top of the structure, including roof, allowing for wind in any direction.

"The overturning moment due to wind pressure shall not exceed 75 per cent of the moment of stability of the structure, unless the structure is securely anchored to the foundation.

"When the stress in any member due to wind does not exceed 50 per cent of the stress due to live and dead loads, it may be neglected. When such stress exceeds 50 per cent of the stress due to live and dead loads, the working stress prescribed may be increased by 50 per cent, in designing such members to resist the combined stresses."

In the new amendment the following wind pressure clauses have been substituted:

"(1) All buildings or parts of buildings, signs or other exposed structures shall be designed to resist, in the structural frame, horizontal wind pressure from any direction.

"(2) When the height of the building is over 100 ft. the assumed wind pressure shall be 20 lb. per square foot of exposed surface from the top of the building down to the 100-ft. level.

"(3) All buildings less than 100 ft. in height, or when the height is less than 2½ times the least width, shall be investigated as to the need for windbracing, but in general wind pressure in such buildings may be neglected

except for buildings in which the height is more than 2½ times the width, mill buildings, shops, roofs over auditoriums, or drill sheds, and structures of similar character, which shall be designed to withstand an assumed wind pressure of 20 lb. per square foot on the upper 50 per cent of their height.

"(4) Ground signs shall be designed to withstand an assumed wind pressure of 20 lb. per square foot of gross exposed area. Roof signs, tank towers, stacks and other exposed structures on the tops of buildings shall be designed to withstand an assumed wind pressure of 30 lb. per square foot of gross exposed area.

"(5) The overturning moment due to wind pressure shall not exceed 80 per cent of the moment of stability of the structure unless the structure is securely anchored to the foundation.

"(6) When the stress in any member due to wind is less than 33⅓ per cent of the stress due to the live and dead loads, it may be neglected. For combined stresses due to wind and other loads, the permissible working stress may be increased 33⅓ per cent provided the section thus found is at least that required by the dead and live loads alone. For stresses due to wind only, the permissible working stress shall be the same as for live and dead loads only, except for rivets and bolts, where the permissible working stress may be increased 33⅓ per cent.

"(7) The design of all members and their connections shall be consistent with the assumed distribution of the horizontal shears due to wind throughout the structure. In analyzing the columns for bending due to wind, it shall be assumed that the column formula (quoted above under column working stresses) produces the maximum allowable extreme fiber stress under live and dead loads at the point where the maximum moment due to wind occurs."

Steel Reinforcement—In the old code, tensile stress in steel reinforcement was stipulated at 16,000 lb. per square inch. In the amendment this stress is increased and grades of steel reinforcement are recognized as follows:

	Lb.
Structural grade billet steel	18,000
Intermediate grade billet steel	20,000
Rail steel bars (straight or machine bent bars only)	20,000
Web reinforcement	16,000
Reinforcement steel in flat slab construction	16,000
Cold-drawn steel wire	20,000

Also, in composite columns, the steel section core can be designed on an 18,000-lb. basis.

Change in Name of Measuring Flume Recommended

A change in name from "improved Venturi flume" to "Parshall measuring flume," on the ground that the former is a misnomer, has been recommended by the special committee on irrigation hydraulics of the American Society of Civil Engineers. The recommendation is approved by the irrigation divison of the society and also by S. H. McCrory, chief, and W. McLaughlin, associate chief, division of agricultural engineering, U. S. Department of Agriculture, and C. A. Lory, president Colorado Agricultural College, Fort Collins. According to a statement by J. C. Stevens, secretary of the committee already named: "This device has been developed by the U. S. Department of Agriculture under the direction of R. L. Parshall, Assoc. M. Am. Soc. C. E. It has found considerable favor in the Western states for measuring irrigation water either for farm deliveries or in large canals. Flumes have been built in sizes from 3 in. to 40 ft., and larger ones are contemplated."

Letters to the Editor

A Forum for Expression of Views by Engineers and Contractors

Wind Design for Buildings Without Diagonals

Sir—In the March 6 issue of *Engineering News-Record* A. N. Van Vleck describes some features of the engineering design of the new Lincoln Building in New York. He says that "the wind stresses were determined by the Fleming portal method." This is apparently the method called II_a described by Robbins Fleming in Sec. 7, p. 459, of "Stresses in Framed Structures," by Hool and Kinne, in 1923.

If a name is to be attached to this method I think it should be called the Burt method, as the late H. J. Burt outlined it in his book "Steel Construction" in 1914. This was, I believe, the first publication of the method, although it was taught to structural engineers at Purdue in 1911.

My work in "Wind Stresses in Office Buildings," presented to the Western Society in 1915, was undertaken to find out whether this method or one of the three methods outlined in *Engineering News-Record*, March 13, 1913, by Mr. Fleming was most nearly correct and where in the height of the building the most important deviations occurred. Wilson and Maney's computation of an office building by the slope deflection formulas presented at the same meeting showed, as mine did, that this method was the best.

Chicago, Ill., March 19, 1930. ALBERT SMITH.

Pennsylvania Railroad's Concrete Practice

Sir—In the production of good concrete as obtained by the water cement ratio theory as used by the Pennsylvania Railroad the following results of test cylinders should prove the dependability of the method. We adhere to Abrams' *B* curve using 5¼ gal. for 3,000 lb. concrete, 6 for 2,500 lb. and 6¾ for 2,000 lb. The percentage of voids method for gravel is used in designing a field mix in the office, using a liberal amount of sand for workability. Typical mixes are: 1 : 1.9 : 2.9 for 3,000-lb. concrete, 1 : 2.3 : 3.5 for 2,500-lb. and 1 : 2.8 : 4.3 for 2,000-lb. In the field, mixes are adjusted for workability for a usual 3 to 4 in. slump, very seldom requiring a change from mix designed in the office. Water carried by aggregates is determined in the field and deducted from total water allowed at mixer. The amount of water is adjusted from time to time according to weather conditions affecting aggregates.

The following are average 28-day compressive strength tests made from 300 cylinders in the field, covering work on nine divisions:

Mix., Lb.	No. of Jobs	Average 28-Day Strength	Range
3,000	3	3,920	3,250 to 4,980
2,500	28	3,240	2,670 to 4,420
2,000	5	2,700	2,200 to 3,250

The following from 760 cylinders are from a large track elevation project consisting of ten separate structures:

Mix., Lb.	Average 28-Day Strength	Range
3,000	3,740	3,400 to 4,230
2,500	3,290	2,930 to 3,680

The following are from jobs using high-early-strength cement for early use which gave better than designed strength in seven days:

Mix., Lb.	No. of Jobs	Average 28-Day Strength	Range
3,000	5	4,500	4,315 to 4,690
2,500	3	4,500	4,240 to 4,990

These results indicate that we are getting about 800 lb. more compressive strength than we design for, a good safety factor. No tests show below designed strengths.

The work mentioned above averages 6.5 bags of cement for 3,000 lb.; 5.7 for 2,500 lb. and 4.7 for 2,000 lb.

ARTHUR B. WANG,
Concrete Inspector,
Pennsylvania Railroad.

Chicago, Ill.,
Dec. 31, 1929.

News of the Week

Construction Census Starts Collecting Comprehensive Data

Government Asks All Contractors to File Detailed Reports—Blanks Now Being Distributed

AUTHORITATIVE statistics on the construction industry will be available for the first time as a result of the first census on construction ever taken, which is now under way as a part of the decennial census. All contractors whose gross business during the year 1929 exceeded $25,000 are required to fill out detailed report blanks now being distributed; it is estimated that more than 150,000 contractors or contracting firms will be canvassed. Initial distribution of the blanks will be by mail, but it is possible that later the assistance of special field agents of the Census Bureau may be utilized. Replies to the inquiries are required by act of Congress. All information furnished, however, will be held in strict confidence, and will be used only for statistical purposes.

Contractors will be required to classify themselves as general contractors, subcontractors or operative builders. Subdivisions under these general classifications will indicate the general class of work done by each firm. Other questions concern the number of skilled and unskilled workmen on the payroll, the total annual payroll, the trend toward rental rather than ownership of construction equipment, and the amount of overhead expenses, such as rent, insurance, bond premiums and other items. All questions on the census blank have been carefully considered by the Bureau of the Census, with the advice of representatives of contractors' associations and the advisory committee on distribution appointed by the Secretary of Commerce, and only those questions considered essential have been included on the blank. As the inquiry is being conducted primarily and chiefly for the benefit of the contractors themselves, they are requested to co-operate to the fullest extent by filling out the blanks completely and accurately and returning them to the government as promptly as possible.

Chicago Council Votes Money for Filtration Promotion

By including $49,000 for filtration in the $17,265,600 Chicago water fund appropriation the city council has made it possible for the water department to take the next step toward acquiring filtered water. For several years an experimental plant has been in operation and tentative plans have been studied. The present appropriation is intended to be used in getting the project properly presented to the public so that it can be financed.

LONGVIEW BRIDGE OPENED TO TRAFFIC

Official dedication of the $6,000,000 Longview bridge across the Columbia River between Longview, Wash., and Ranier, Ore., took place March 29, with President Hoover pressing a button in Washington which opened a barrier in the center. The structure has a center span of 1,200 ft. with a vertical clearance of 196 ft. above mean low water. With its wooden approaches, it has a total length of 8,289 ft. The 27-ft. roadway is flanked by two 3-ft. sidewalks. Design and supervision were in charge of the Strauss Engineering Corporation, with the Bethlehem Steel Co. as general contractor. J. H. Pomeroy & Co., erected the steel, the Pacific Bridge Co. the piers, and Lindstrom & Feigenson the timber approaches and concrete deck. The structure is owned and will be operated as a toll bridge by the Columbia River Longview Bridge Co.

Federal Acquisition of New York Barge Canal Recommended

Army Engineers Advise Improvement and Enlargement—Transfer of Control Held Justified

RESULTS of a study of the New York State Barge Canal, made by a special board of engineer officers appointed for the purpose, have been forwarded by the Chief of Engineers to the House committee on rivers and harbors. The study was made to determine the cost and advisability of deepening the canal, and at the same time raising bridges over the waterway to increase clearances, for its entire length from Albany to Tonawanda, including the branch to Oswego.

The board estimates the cost of deepening the entire waterway to 13 ft. (except locks) and of raising bridges in sections subject to floods, at $26,906,210, including interest during construction. The estimated increase in annual charges is $1,351,248. Replacement of the flight of locks at Lockport by a single lock would increase the capacity of the Tonawanda section, but this is not held justified as it is believed that completion of the Welland Canal will divert the bulk of Barge Canal traffic to the Oswego section. The board finds that the present capacity of the canal is about 6,800,000 tons, and estimates that by 1938 there will be potential traffic amounting to 7,500,000 tons, necessitating additional improvements by this date, if not earlier.

Future Enlargement Necessary

The most practicable and economical method of providing this increase in capacity appears to be an increase in depth to 14 ft. outside of the locks, progressive widening to permit full use of the greater depth, and the raising of bridges to provide a 20-ft. clearance. Such of these improvements as might prove necessary in the next ten or fifteen years would probably cost about $50,000,000. While it is possible that New York State might carry out this program, the report points out that the State has already spent about $146,000,000 on this waterway and that, since at least half of the canal traffic consists of interstate and foreign commerce, there is good reason for the claim that the federal governments should bear the cost of future improvements. As it is essential that the work of improvement be conducted so as not to interfere with present traffic, it is recommended that the state transfer the canal to the federal government. Prospective increase in the value of the system following the

completion of improvements now contemplated or in progress on other waterways is urged as an additional reason for the transfer.

No legal authority for such a transfer exists at present, and some time must necessarily elapse before it can possibly take place. Although a program of progressive improvement seems advisable, the board advises that no program be adopted until the transfer can be effected. A resolution memorializing Congress to take over and develop the barge canal system has already been introduced before the New York legislature, which also provides for the submission to the voters of an amendment to the state constitution permitting transfer to the federal authorities.

Railway Loops Under New York Proposed for Commuters

Relief of congestion in New York City by the construction of a north and south distributing railway in Manhattan which would connect with railroad tunnels under the North and East rivers to form a loop system is recommended in a report submitted by the Suburban Transit Engineering Board, which has been studying the transit situation in New York for the Port of New York Authority. Membership of the board includes representatives of all the railroads, the Board of Transportation of New York City, the New Jersey Transit Commission and the supervisors of Westchester, Nassau and Suffolk counties. In suggesting the new construction no consideration has been given to legal, financial or operating problems, nor as to how or by what agency any of the facilities would be provided, financed or operated.

As part of the report figures are presented analyzing results of a census of commuter traffic made by the board. This analysis shows that the railroads are now bringing nearly 23,000 more suburban passengers into Manhattan daily than they did on corresponding days two years ago; that 56 per cent of the suburban railroad commuters use New York City's own transportation facilities to reach their destinations; and that 55 per cent of Long Island's railroad passenger traffic to Manhattan originates within the limits of New York City.

To relieve the congestion of present facilities, the board recommends the construction of a north and south distributing line which would connect with the present Long Island Railroad by means of tunnels under the East River at 57th St. and the Battery, and with New Jersey railroads by tunnels under the Hudson at 57th St. and the lower end of Manhattan. All tunnels would have two tracks, with trains operating around the loops in each direction, and would be independent of the present city subway system. In addition, it is recommended that the existing Hudson & Manhattan Railroad tunnels be extended from 33d to 57th St.

Federal Aid Increase Becomes Law

Signing of the federal-aid bill by President Hoover April 4 was the final step in increasing the total amount of federal funds granted to the states for road-building purposes from $75,000,000 to $125,000,000 for the fiscal years beginning July 1, 1930, 1931 and 1932. The extra $50,000,000 may be placed under contract immediately. Provisions of the act as finally passed were given March 27, 1930, p. 541. The maximum amount of federal money which may be expended per mile of road was increased from $15,000 to $25,000, subject to the requirement that the 7 per cent system of each state must be completed before the increased limit becomes effective, and to certain other exceptions.

Chicago to Receive Texas Gas Through 950-Mile Pipeline

Preliminary negotiations have been completed for the construction of a pipe line to deliver natural gas from the Texas Panhandle to the Chicago area, according to an announcement made by Insull, Son & Co. The initial line, to be built by Henry L. Doherty & Co., will consist of a single main and pumping stations, probably of 22-in. pipe, and will be constructed so as to facilitate laying parallel mains when this becomes necessary. The gas will be distributed in Chicago by the Peoples Gas, Light & Coke Co. Associated with the Insull company in the construction of the line are the Cities Service Co., the Texas Co., the Phillips Petroleum Co., the Skelly Oil Co., the Columbian Carbon Co. and the Standard Oil Company of New Jersey.

Montreal Terminal Construction Started

Work has been begun on the section of the new Canadian National Railway terminal at Montreal, which lies in the southwest of the city between Turcot and Pointe St. Charles. A force of men is preparing for the construction of six new subways in that part of the city. In the construction of these subways the tracks will be partly elevated and the street partly depressed, thus affording greater facilities for the construction and maintenance of sidetracks to serve industrial plants. Concurrently with the construction of the subways, at an estimated cost of $2,500,000, work will be started on the central station itself, and the new route linking it with Victoria bridge. Excavation work, to be started about May 1, will require the removal of about 1,100,000 cu.yd. of earth and rock. The program includes another branch line to be built in the eastern part of the city running from Hochelaga St. at Longue Point, to Eastern Junction, a distance of about 10½ miles, which will reduce by more than 80 miles the existing distance by C.N.R. between Longue Pointe and Turcot. Another branch line will extend from a point west of Pointe Claire to a point north of Val Royal, over which trains coming from the western part of the island will enter the central station.

High-Tension Line to Connect Cincinnati and Louisville

Construction of an electric transmission line 82 miles long and costing approximately $1,000,000 for interchange of power between Louisville and Cincinnati is provided in a contract which has been signed by officials of the Louisville Gas & Electric Co. and the Cincinnati Gas & Electric Co., according to a recent announcement. Most of the right-of-way has been purchased and it is planned to begin construction immediately. The line is expected to be in operation next fall. Plans for the interconnection call for a normal capacity of 40,000 kw., with electricity being transmitted at 132,000 volts. Most of the territory traversed by the proposed line is now being served with electric power and it is not planned to tap it for this purpose.

California Utilities United Into Large System

Application has been made to the Railroad Commission of California for approval of an agreement entered into by the North American Co., New York City, and the Pacific Gas & Electric Co., which would form one of the largest interconnected power systems under single ownership in the United States, as well as materially strengthening the position of the Pacific company in respect to the distribution of natural gas in the San Joaquin Valley. The agreement, which has been approved by the boards of directors of both companies concerned, transfers to the Pacific Gas & Electric Co. control of the Great Western Power Company of California, the San Joaquin Light & Power Corp. and the Midland County Public Service Corp., together with subsidiaries including the Feather River Power Co., the California Electric Generating Co., the Napa Valley Electric Co. and others.

The field of operations of the new company will extend from Bakersfield on the south to Eureka in the north, and will include the natural gas business of the cities of the San Joaquin Valley, as well as a large field now served in northern California. The combined properties will have assets of approximately $650,000,000, gross revenues exceeding $87,000,000 annually, will serve approximately 1,200,000 customers and will have a generating capacity of 1,473,000 hp.

Agreement Reached by Owners of Alumina Cement Patents

By an agreement executed March 28, 1930, between the Atlas Lumnite Cement Co., a subsidiary of U. S. Steel Corporation, and Edwin C. Eckel, Washington, D. C., the latter withdraws his opposition to the proposed extension of the Spackman patents, while the company releases all licensees under Eckel patents from liability for possible infringement of the Spackman patents. This means, according to Mr. Eckel, that reasonable competition between the two main alumina cement-making processes in the United States will be permitted, while at the same time unfair competition from foreign sources will be prevented.

There are at present no licenses existing under Eckel patents in the United States. Mr. Eckel states that cement- or steel-making companies now in operation will be given preference in issuing such licenses.

Clay Products Form Subject of Three Recent Meetings

Clay products, particularly brick, occupied the attention of three groups meeting in Washington, D. C., during the past week. The Heavy Clay Products Institute held its first annual meeting on April 3. This session was concerned principally with introducing the newly formed trade body to those in attendance and explaining the scope of its work in the brick and terra cotta field. On the following day the group inspected exhibits of brick and tile research at the Bureau of Standards.

Two brick meetings were held on April 2 without direct connection with the institute, but overlapping in personnel and interests. For the sixteenth year the annual variety survey report of the vitrified paving brick industry was presented under auspices of the Commerce Department and the National Paving Brick Manufacturers Association. Success of the simplified practice program of the committee is shown by the fact that last year 87 per cent of the total shipments of vitrified paving brick fell within the six recognized types and sizes. The output was 277,000,000 tons. These figures may be contrasted with 52 per cent and 416,000,000 tons in 1916. The percentage under approved classifications has steadily mounted. The committee unanimously voted to continue the simplified practice recommendations for another year without change. No other types had shown sufficient increase to warrant inclusion in the recognized list, according to the decision.

On the same day the brick committee of the American Society for Testing Materials considered the advancement of paving brick standards, now tentatively formulated, into final form. Revisions in the specifications for sand-lime and clay building bricks also were discussed. These changes will come before the June meeting of the A.S.T.M.

New York-New Haven Toll Road Proposed by Private Company

Express Highway Would Revert to Public Upon Demand—Charter Asked From New York

CONSTRUCTION of a $200,000,000 express highway, to be owned and operated by private capital, is proposed in a bill which has been submitted to the New York State Legislature authorizing the New York & New England Motorways Corporation to build such a road from a point in New York City near the Fort Lee bridge, through Westchester County to the Connecticut state line, where it is proposed to connect with a similar roadway to be extended through Connecticut to New Haven and, eventually, to Boston, Mass. It is proposed, in New York State, to build the road for the most part on the right-of-way of the New York, New Haven & Hartford Railroad and lands belonging to Westchester County. The project is sponsored by the New York & New England Motorways Corporation, of Stamford, Conn., of which Lester P. Barlow is president, Wendell W. Chase vice-president and Ernest P. Goodrich consulting engineer.

By the terms of the bill, the corporation would be authorized to enter into a contract with the railroad company granting it exclusive right to operate buses upon the motorway, provided that the railroad meets the requirements of the state utilities commission in regard to facilities and charges. Should the railroad fail to meet these demands, it is proposed that any private corporation may apply to the state and be granted permission to operate such buses as the railroad does not furnish. Recapture of the project by the state is provided for upon one year's notice and the payment of the original cost to the promoters, plus 6 per cent interest unless this has been paid from current revenues. All construction expenses would be under the supervision of the state. Pending recapture, the project would be financed by the sale of bonds secured by the revenues to be derived from operation of the system. Receipts would be augmented by the granting of concessions for the sale of oil and supplies along the route.

Although no detailed plans have been published, the general description calls for two traffic lanes in each direction, a slow-speed track with a maximum speed of 30 miles an hour, and a high-speed track with a minimum speed limit of 35 miles an hour and no maximum. There would be no grade crossings of any kind. The slow-speed and high-speed tracks would be separated by approximately 20 ft. of packed gravel, and the two directions of travel by a metallic fence which would serve as a barrier to prevent turning and also to cut out glare from headlights of approaching cars.

Brief News

EXPLOSION OF GAS escaping from a leaky main in Broadway, New York City, on April 4, disrupted telephone communication in a large part of the city and temporarily crippled the traffic control and fire alarm systems.

CLEVELAND will build a $2,500,000 municipal stadium with a permanent seating capacity of 80,000. A suit to enjoin the city from building the stadium has been dismissed by the Ohio Supreme Court, and contract for the construction has been awarded to the Osborn Engineering Co., of Cleveland.

GRADE CROSSING ELIMINATION on municipal and county roads in California is provided for in a $10,000,000 bond issue to be voted on in November in that state. Funds would be divided among the counties in accordance with the present allocation of state highway funds.

SKYSCRAPERS over twelve stories in height have been prohibited in Germany by order of the German government. In some provinces the maximum height of buildings is limited to ten stories. Dwellings cannot exceed five stories in any part of Germany. These limits were established after a canvass of sentiment in German municipalities.

REFUND of a portion of the $14,500 fee paid to the State of California by San Gabriel County for supervision of construction of the abandoned San Gabriel dam will be sought by the county.

CONSTRUCTION OF A SECOND RAILROAD connecting Mesopotamia with Teheran, approximately 600 miles, is under consideration by the Turkish government, which is negotiating with the Siemens Bauunion and Julius Berger, contractors on the northern portion of the Transpersian Railway.

UPLAND, Calif., is attempting to reclaim sewer water for use in irrigation, according to City Engineer R. G. Manes. This effort is being made to reduce the load on the domestic water supply. The city of Ontario is also working on the same plan and the proposal has been made that one large sewer reclamation plant be established to serve both communities.

A 1,000,000-GAL. STEEL WATER TANK 212 ft. high has been added to the water supply of Gastonia, N. C. It is 56 ft. in diameter with a hemispherical bottom giving a total depth of 62 ft., and contains over 400 tons of steel.

QUARTERS for officers and non-commissioned officers at Randolph Field, Texas, will be constructed by the Kenneth L. Colburn, Inc., Pasadena, Calif., recently awarded a contract for the construction of 93 buildings on a low bid of $1,250,000. All grading work at the field has been completed and approximately 1,000 acres have been seeded. Water and sewer lines have been laid,

and gas, electric and telephone lines and storm sewers will soon be under construction. The field is being prepared as the "West Point of the Air" of the U. S. Army.

ILLINOIS STATE GEOLOGICAL SURVEY will celebrate the 25th anniversary of its founding by ceremonies to be held April 30 and May 1 at Urbana.

AS CHANGING OF CLOCKS is prohibited by law in Milwaukee, Wis., a plan to secure the benefits of daylight saving by advancing working hours has been recommended by the Engineering Society of Milwaukee and other local organizations.

GRADE-CROSSING ELIMINATION BONDS to the amount of $30,000,000 have been authorized by the legislature and Governor of New York State. Of this amount $13,500,000 will be used within the city of Syracuse.

THE BOUNDARY CHANNEL SPAN of the Arlington Memorial bridge, which recently suffered slight damage as a result of a fire in the formwork, is being constructed by the N. P. Severin Co., Chicago, Ill., as general contractor, not as subcontractor, as was stated in our issue of March 20, p. 497.

MERGER of three engineering and architectural organizations has joined Fletcher-Thompson, Inc., Bridgeport, Conn., and Newark, N. J.; the Samuel M. Green Co., Springfield, Mass.; and Charles H. Moores Co., Inc., formerly Moores & Dunford, Inc., of New York City. Although associated, the organizations will still maintain their individual identities, with offices in all cities mentioned.

Army Engineers Study Salt Water Barrier on San Francisco Bay

A barrier across an upper arm of San Francisco Bay to keep ocean water away from the deltas of the Sacramento and San Joaquin rivers has been proposed many times in recent years. About three years ago the State of California made a survey and report on the project. In connection with a study of inland water resources and the runoff from the central valleys, the Corps of Engineers has recently begun a comprehensive study of the salt water barrier problem, co-operating with state and other federal interests.

Prominent in the objectives of the present study are a determination of just what tidal prism is involved and what the probable effect of the barrier would be on navigation and on navigable channels. Extensive fieldwork is being required because very little data were found as a basis for the studies.

The report is to be completed during the present year. A staff of about 50 men is now at work on the study, headed by C. A. Mees, consulting engineer, Charlotte, N. C., working under the personal supervision of Major E. H. Ropes, Corps of Engineers, U. S. A.

Keystone Photo

MANHATTAN COMPANY BUILDING LOOKS DOWN ON NEW YORK CITY

How the recently completed 925-ft. tower of the Manhattan Company, formerly the Bank of Manhattan building, looms above its lesser neighbors in the financial district of down-town New York is well shown by this photograph, taken from the top of the Woolworth building since the scaffolding was removed from the new structure.

Prominent Engineers Participate in A.S.M.E. Anniversary

The part played by the engineer in the advance of civilization during the past half century in sixteen leading regions of the world was depicted by prominent engineers representing their nations at the fiftieth anniversary celebration of the American Society of Mechanical Engineers, held in New York City, Hoboken, N. J. and Washington, D. C., April 5-9. The United States was represented by C. E. Grunsky, president of the American Engineering Council, and Great Britain by Loughran Pendred, editor of *The Engineer*, London. Other countries and their representatives were:

Canada, C. H. Mitchell, dean of the faculty of applied science of the University of Toronto; Germany, Dr.-Ing. Conrad Matschoss; France, Georges Claude; Japan, Dr. Masawo Kamo, of the Tokyo Imperial University; Italy, Senator Luigi Luiggi; Austria, Hofrat-Ing. L. Erhard, director of Technisches Museum, Vienna; Belgium, Baron Gaston de Bethune; Netherlands, Prof. Ir. D. Dresden; Scandinavia, Vilhelm Nordstrom, of Stockholm, Sweden; and Switzerland, Prof. Dr. Aurel Stodola, professor at the federal technical high school in Zurich. South America's representatives were Prof. Donato Gaminara, of Uruguay, a member of the Pan-American Highway Commission, and Prof. Julio Garzon Nieto, a chief engineer with the Colombian government.

To commemorate the anniversary each of these engineers was presented with a medal symbolizing the engineer, his past and present achievements. The occasion was held opportune for the presentation of other medals awarded by the society. The first Hoover medal, awarded by the four founder societies, was presented to Herbert Hoover in recognition of his humanitarian services. The Guggenheim medal for notable achievement in the advancement of acronautics, which gives recognition solely to engineering and scientific achievement in the technology of air navigation, rather than to great achievement in the operation of aircraft, was awarded to Orville Wright for "design and construction, with his brother now deceased, of the first successful engine-propelled airplane." The American Society of Mechanical Engineers medal was given William LeRoy Emmet, of the General Electric Co., for his contribution in the development of the steam turbine and the electric propulsion of ships. The Gantt medal was presented to Fred J. Miller, former editor of *American Machinist*, for achievement in scientific management. For the presentation of the best technical paper before the society Joseph W. Roe, of New York University, was awarded the Melville medal.

Am.Soc.C.E. Meets April 23-25 at Sacramento

Events scheduled on the program for the spring meeting of the American Society of Civil Engineers, to be held at Sacramento, Calif., April 23-25, include the presentation of two major papers and meetings by the highway, irrigation, structural and surveying and mapping divisions. In addition, the society will preside at the dedication of a memorial to Theodore D. Judah, first chief engineer of the Southern Pacific Railway. There will also be the usual social events and inspection trips to the Suisun Bay bridge of the Southern Pacific Railroad and the Salt Springs and Pardee dams.

The two main papers to be presented at the technical session, to be held April 23, are: "The Problem of Maximum Conservation of Water Resources, With Special Reference to the California Plant," by Edward Hyatt, state engineer of California, and "State Supervision of the Design and Construction of Dams," by M. C. Hinderlider, state engineer of Colorado. The divisional meetings will be held on April 24. In the highway division, subjects to be discussed include low-cost bituminous-treated roads, western highway practices and prequalification of contractors. Before the irrigation division, F. E. Weymouth, chief engineer

of the Los Angeles Metropolitan Water District, will discuss "The Proposed Colorado River Aqueduct and Metropolitan Water System." There will also be papers on the foundations of the Rodriquez dam in Mexico and the development of hydro-electric power in relation to irrigation. Papers describing the Suisun Bay bridge and the Salt Springs dam will be presented before the structural division, while the surveying and mapping division will hear papers on the preliminary surveys for the Colorado River aqueduct and on aerial mapping.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

No Change in Flood-Control Plans Imminent—Propose New Control for Interstate Power

With the idea of determining what steps can be taken before the adjournment of this session of Congress, the flood-control committee of the House of Representatives expects to have a meeting shortly after the middle of the month. Some members of the committee doubt that anything worth while can be done until the engineers have submitted the detailed reports they now are preparing. Without definite figures as to costs under the changed conditions resulting from court decisions and without engineering data as to the reservoir situation, it is apparent that little can be done. Any amendment to the flood-control act recommended by the committee prior to the submission of these reports would hardly be considered seriously by the House.

As it now seems likely that the engineers will not be able to report on their special studies in time for consideration at this session of Congress, there is little prospect for any further important activity in the committee at this session. It is possible that public hearings will be held to take testimony from witnesses interested in headwater reservoirs. Advocates of such projects feel that no opportunity has been offered to build up a connected record on that phase of flood control. What has been said appears in fragments throughout the printed records. So far as is known there is no objection in the committee to the presentation of that testimony.

Illinois Waterway Acquisition

By unanimous action, the House rivers and harbors committee voted last week to authorize the federal government to take over and complete the Illinois section of the Lakes-to-the-Gulf waterway. It was agreed to incorporate an amendment in the pending rivers and harbors bill authorizing the appropriation of $7,500,000 to carry the project to completion. An amendment was adopted for the purpose of appeasing lake state interests which provides that nothing in the act shall be construed as authorizing any diversion of water from Lake Michigan.

In discussing the matter, members of the committee reached the conclusion that it would be improper to attempt to deal with the diversion of water until the Supreme Court has handed down its decree in the Chicago drainage canal case. It is not believed, however, that there will be any great difficulty in obtaining permission for the diversion of water for navigation.

The project authorizes the completion of a 9-ft. depth from Lake Michigan to the Mississippi. All doubt as to the legal question involved in taking over a state project has been removed by a report submitted by the Attorney-General. While the Constitution of the State of Illinois prohibits disposition of the waterway, the Attorney-General has expressed the opinion that the Federal Constitution is a higher authority and permits the exercise of federal regulation of commerce between the states.

New England Railway Control

Extension of the Pennsylvania Railroad's holdings in the New Haven and the Boston & Maine has placed railroad consolidation in New England in a light that is causing the Baltimore & Ohio and the Van Sweringen systems some anxiety regarding their share of traffic from and to that territory. Allocation of the Lehigh & New England and the Lehigh & Hudson River to the New Haven, and the Delaware & Hudson to the Boston & Maine, as proposed in the Interstate Commerce Commission's consolidation plan, would have the effect of moving the point of interchange with the trunk lines 100 miles to the west of the Hudson River. If the Pennsylvania were permitted to extend its interest in the two New England systems, the less favored trunk lines may whistle for interchange traffic with the bridge lines.

The Pennsylvania's $10,000,000 investment in the New Haven has been supplemented by further purchases made by the Pennroad Corporation, and it is also reported that the holding company has obtained a substantial interest in the Boston & Maine. The two trunk lines do not challenge the New York Central's right to tap New England through the Boston & Albany, but it may be expected that they will unite to protect their interest in New England traffic either by insisting that the independence of the New England systems shall be scrupulously respected or that, if the Pennsylvania is able successfully to defend its claim to the New Haven, they should be permitted to tie up with the Boston & Maine.

Reorganization of Power Commission Proposed

To carry out the President's recommendations for a limited exercise of federal authority in the interstate transmission of electric energy, a bill was introduced last week by Representative Parker, of New York, providing for the reorganization of the Federal Power Commission. Mr. Parker is chairman of the House interstate commerce committee. The bill has been referred to that committee for consideration. It is understood that the measure has the support of the administration.

As it has been revealed that only 10 per cent of the total amount of power consumed annually in the country is transmitted across state lines, Mr. Parker believes that it is desirable to interfere as little as possible with the authority of state regulatory bodies. He believes that federal regulation should be invoked only in cases where the Supreme Court has held that the states may not act.

Specifically, the bill provides for the reorganization of the Federal Power Commission so that it will be composed of three commissioners to be appointed by the President subject to approval by the Senate. Each commissioner will receive an annual salary of $12,000. The tenure of office is fixed at six years. To carry out its activities, the commission is authorized to employ an executive secretary and such other officers and employees as may be necessary. Power plants owned wholly by the federal government or by state governments are exempted from the provisions of the bill.

It is provided that the bill shall apply to rates and charges to any person engaged in the distribution of power for ultimate consumption, for power sold in interstate commerce, for the transmission of interstate commerce of power or for other facilities or services furnished in connection with such sale or transmission. The Federal Power Commission is charged with the responsibility of seeing that all rates and charges shall be just and reasonable. To carry out the administration of the act, the commission, acting on its own responsibility and through the joint boards, is authorized to subpena witnesses and to require the production of documentary evidence. It is further provided that nothing in the act shall be construed as extinguishing any remedy or right of action under other law.

The Business Outlook

United States Steel Corporation production stepped up from 80 per cent to 82 per cent, and the independents' from 66 per cent to 69 per cent. Bethlehem expects to maintain 85 per cent of capacity operation during April. Structural steel inquiries are large, but actual awards for the week were relatively low, only 22,000 tons. Metropolitan New York district general building contracts for March were 18 per cent over those for February and only 11 per cent under those for last March. The general impression is that employment tended to pick up slightly in March.

—The Business Week, April 9.

Personal Notes

H. ELTINGE BREED, consulting engineer, of New York City, has gone to Russia, where he will be engaged in engineering work until fall. During his absence his work here will be in charge of his associate, Prof. Elmer G. Hooper, school of engineering, New York University.

B. C. MCCURDY, of Belleville, Ill., has been appointed superintendent of the St. Clair County highway department. Mr. McCurdy has been acting superintendent since the death last January of David O. Thomas, whose chief assistant he was for eight years.

ISAAC S. WALKER announces the opening of an office in Philadelphia for the practice of engineering, and will devote special attention to public utility and sanitary engineering, in which fields he has been actively engaged for 28 years.

N. A. GILMAN, assistant city engineer, has been placed in charge of the water department of Yakima, Wash., by the city commission.

J. L. D. SPEER, JR., has been appointed chief engineer of the Chesapeake & Potomac Telephone Co., Baltimore. He succeeds Frederick J. Irish, who becomes general manager.

RAY J. DESMARAIS, who has been assistant city engineer of Windsor, Ont., has been appointed city engineer, succeeding M. E. Brian, who has resigned to become vice-president of the Cadwell Sand & Gravel Co., of Windsor.

F. Y. HARCOURT, of Port Arthur, Ont., has been appointed resident engineer, in charge of the offices of London district, for the federal department of public works. He succeeds H. B. Craig, who retired recently to engage in private practice.

AARON I. RAISMAN was the honor guest on March 25 at a dinner in New York in celebration of his recent elevation to the post of chief designer of the New York City Board of Transportation. Mr. Raisman, who was graduated from Columbia University in 1898, has had much of the responsibility for the design of New York's existing rapid transit systems as well as the new systems now under construction.

JOHN L. WEBER, formerly a civil and hydraulic engineer of Trenton, N. J., has formed a corporation under the name of John L. Weber, Inc., to handle hydraulic, sanitary, municipal and structural projects. With Mr. Weber are associated Edward K. Bryant, Richard B. Bechtel and Walter C. Kennedy. The corporation's offices are in Trenton.

MAJOR VIRGIL L. PETERSON, who has been assistant director of public buildings and public parks in Washington, D. C., has been assigned by the War Department to duty in the office of the Chief of Engineers and will have charge of the miscellaneous civil section. In this capacity he will have supervision of bridge permits, harbor lines and permits for construction in the various navigable waters for the whole United States, and in addition will have supervisory duties over the Alaska Road Commission.

FRANCISCO GOMEZ-PEREZ, who has been for more than a year principal assistant to the consulting engineer in the construction of the $3,500,000 dam at Rodriguez, Lower California, Mexico, has returned to private practice in Mexico City.

Obituary

LOUIS RUSSELL ASH, of the engineering firm of Ash, Howard, Needle & Tammen, died in Kansas City April 7 of heart disease at the age of 56. Mr. Ash was born in Uniontown, Ky., and was educated at the University of Arkansas. His first professional work was the construction of a municipal electric light plant for Fayetteville, Ark., after which he did some electrical work for the Northwest Engineering Co., of St. Paul, Minn., and, in 1895, became professor of civil engineering and later of mathematics at Coe College, Cedar Rapids, Iowa. After six years of teaching he became associated with the engineering firm of Waddell & Hedrick as assistant engineer in charge of the drafting room. From 1907 to 1910 he was associate engineer with Ira G. Hedrick, consulting engineer. Following this he was for three years city engineer of Kansas City, and then associate engineer and office manager for the engineering firm of Waddell & Harrington. In 1914 Mr. Ash helped form the engineering firm of Harrington, Howard & Ash, with which he remained associated except for a brief interlude as the first city manager of Wichita, Kan., until the recent reorganization of the company into the firm of Ash, Howard, Needles & Tammen. Besides being a well-known designer of bridges, Mr. Ash was prominent in municipal affairs, being a member of the commission which drafted a new charter for Kansas City, and also of the City Planning Commission of that city. He was a member of the American Society of Civil Engineers and of the American Concrete Institute.

EDWARD ALFRED BURKE, who served the city of San Francisco at various times during the last twenty years as highway and street improvement expert, died in that city on March 31. He was graduated from the University of California in 1903.

HAMPTON LEE SHAW, city engineer of Houston, Tex., died on April 1, half an hour after he left his office, death being due to a blood clot on the brain. A few hours after his death the city council honored his memory by naming for him a city building, to be known hereafter as the Hampshaw Building.

EDWIN DURYEA, a past president of the San Francisco Section of the American Society of Civil Engineers and a director of that society from 1916 to 1918, died in Palo Alto, Calif., April 1, at the age of 68, after a long illness. In 1920 he had retired from the engineering firm of Duryea, Haehl & Gilman, of which he had been a member since 1907. A native of New York, Mr. Duryea was graduated from Cornell University with the degree of civil engineering in 1883 and entered the engineering department of the Northern Pacific Railway. The next eight years he spent in the construction of bridges over the Mississippi, Missouri and Ohio rivers and in Kansas and Michigan. From 1891 to 1895 he served as engineer or superintendent for various contracting firms in Chicago and New York, and then became resident engineer for the Williamsburg bridge in New York City, a position he held for five years. After two years in private practice in New York he was chief engineer for the Bay Cities Water Co. in San Francisco from 1902 to 1910. From 1910 to 1913 he was engineer in charge of the San Joaquin (Calif.) Irrigation District. Following the San Francisco earthquake and fire in 1906, Mr. Duryea was appointed a member of the committee to advise on the rehabilitation of the city.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 23-25.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

INTERNATIONAL RAILWAY CONGRESS, Madrid, Spain, May 5-15. American vice-president, T. S. Morgan, 119 West 42d St., New York.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS will hold its fifth annual meeting April 14-16 at St. Louis. F. E. Dishner, Detroit, is secretary.

FLORIDA ENGINEERING SOCIETY will hold its annual meeting April 17-19 at Ocala. P. L. Reed, Gainesville, is secretary.

ILLINOIS SECTION, American Water Works Association, will hold its annual meeting at the Stevens Hotel, Chicago, April 23-24. J. J. Doland, Urbana, is secretary.

NATIONAL ASSOCIATION OF RAILROAD TIE PRODUCERS will hold its twelfth annual meeting at Memphis, Tenn., on April 29 to May 1. Papers on ties and timber treatment by railroad engineers and representatives of the lumber industry are on the program. Roy M. Edmonds, St. Louis, is secretary.

PACIFIC NORTHWEST SECTION, American Water Works Association, will meet April 24-26 at Portland, Ore.

SOUTHEASTERN SECTION, American Water Works Association, will hold its annual meeting April 15-17 at Savannah, Ga. F. W. Chapman is secretary.

Construction Equipment and Materials

Plan Road Machinery Exhibits

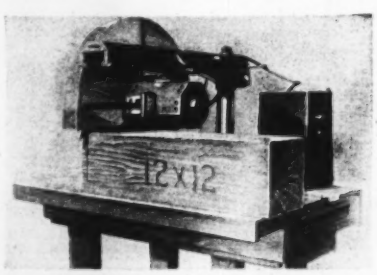
Arrangements are now being perfected for exhibitions of roadbuilding equipment and machinery in three different parts of the country. The first of these will be held May 6-8, when the Massachusetts Highway Association will hold its sixth annual Road Machinery Show in South Boston, Mass. John M. McCarthy, Boston, is secretary of the association.

Two exhibits of highway equipment are planned at the time of the sixth International Road Congress, to be held next fall in Washington, D. C. In connection with this, an exposition will be held in the Washington Auditorium and in outdoor space adjacent thereto Oct. 7-10. Details can be obtained from Charle, M. Upham, engineer-director of the American Road Builders Association, Washington, D. C. Also in connection with the International Road Congress, the Michigan Municipal Contractors Association, Detroit, Mich., is proposing to hold an international road show and exposition in Detroit during the week of Oct. 20. A program is being arranged to include speakers of prominence. The exhibition in connection with this meeting will be held at the State Fair Grounds.

New Developments

Cutting Heavy Timber on the Job

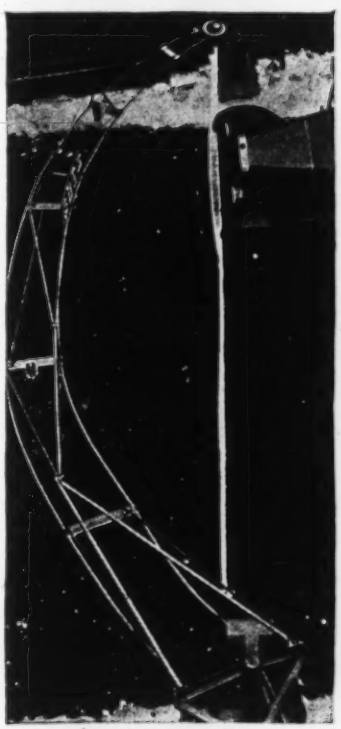
Portable electric sawing equipment for handling timber up to a maximum of 12x20 in. is now being supplied by the DeWalt Products Corp., Lancaster, Pa., which has recently introduced two new heavy-duty saws known as models L and T. Both these machines are equipped with saw blades operating at 1,750 r.p.m. direct-driven by electric motors operating on either two- or three-phase current at 220 to 550 volts. The saw is mounted on an arm which may be raised or lowered to regulate depth of cut, the maximum height being 36 in. The capacities of the two models, at a maximum, are 12x12- and 12x20-in. timbers. The model T is mounted on an all-metal table equipped with steel conveyor rollers for easy handling of heavy material. An elevating device is operated by a wheel in front of the table to give rapid elevation and ease in operation.



PORTABLE ELECTRIC SAW FOR HEAVY CUTTING

Flexible Crossing Guard Stops Vehicles Without Shock

In the belief that the rigid type of crossing gate not only is ineffectual but also causes damage to both gate and vehicle in case of accidental contact, a yielding barrier known as the Highway Guardian has been developed by the Franklin Railway Supply Co., New York City. This consists of three major parts: a yielding barrier arm of skeleton steelwork formed in the shape of a crescent; a pedestal support which houses the operating mechanism; and a snubber which acts as a cushion to provide yielding resistance when the gate is struck by a vehicle. Operation may be manual, semi-automatic or automatic.



YIELDING GATE FOR HIGHWAY GRADE CROSSINGS

Special safety devices make automatic operation possible without danger of damaging vehicles. For example, the structure is so balanced that, when being lowered to closed position, a force of only 5 lb. is sufficient to stop its motion. Even if lowered on top of the passing car, no serious damage will result. The gate itself is pivoted both vertically and horizontally to the pedestal, and the engaging lock on the snubber is so arranged that the barrier can be pushed aside by a vehicle caught on the track after lowering, and also by one traveling toward the crossing which may strike the gate before it has reached engagement or fully closed position. The snubber is equipped with a hydraulic dashpot offering resistance proportional to the speed and weight of a vehicle striking the barrier and gradually stopping this vehicle within a definite distance. Provision is also made for the attachment of warning lights and audible signals, set in operation by the mechanism of the gate itself.

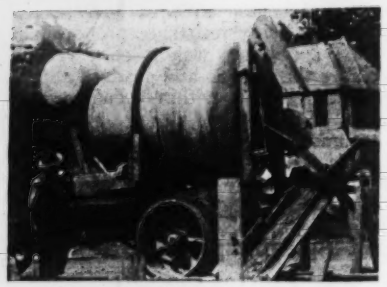
All-Steel Scraper Controlled by Tractor Operator

Simplicity in operation characterizes a new heavy-duty scraper offered to contractors by the Shaw Excavator & Tools Co., Worthington, Ohio, in three sizes with level full capacities of 1½, 2¼ and 4 cu.yd. Each size will actually carry a larger load when rounded up. The scrapers are designed for use with tractors of the crawler type developing from 20 to 50 hp. at the drawbar and are particularly adapted to moving dirt distances of 2,000 ft. or less. Control of the machines is in the hands of the tractor operator, who handles excavating, carrying, dumping and leveling or grading by means of two levers controlling a winch. The latter is installed on the rear of the tractor and connected with its power take-off. Depth of cut is regulated by an oblong stop block on each side of the machine mounted on a bolt through an eccentrically drilled hole. Rotation of this block gives a cam action, regulating the height of the bucket lip. After the scraper is loaded the operator engages the winch and lifts the front of the scoop to carrying position, at which the scoop is inclosed on all four sides. For dumping, the operator again engages the winch, and raises the front end of the scoop until the contents fall out through the swinging rear gate, which may be fixed to act as a spreader if desired. Advantages claimed for this unit include one-man operation, short turning radius, no gears or connections depending upon the traction of the wheel and ability to dump while the unit is standing still or in motion in either direction.

SCRAPER IN DIGGING POSITION

Chain-Driven Body Mixes Concrete on the Road

Any make of truck of suitable capacity can be used as the mounting for a new Rex Mix-Haul, developed by the Chain Belt Co., Milwaukee, Wis., for the mixing and transportation of concrete. This is a self-contained unit of 2-, 3- or 4-cu.yd. capacity carrying its own water tank and motor for rotating



TRUCK-MOUNTED MIXER DISCHARGING CONCRETE

the drum. Light weight is obtained by the use of high-strength steel in place of cast iron, and a low center of gravity with large drum diameter by swinging the weight between supporting frames. Due to the three-point suspension, the drum cannot be affected by twisting of the truck frame. The drum is supported at the rear by two drum rollers, Timken mounted, and at the front by an SKF self-aligning ball bearing at the center. Rotation is by means of a gasoline motor driving through an inclosed transmission which runs in oil, with final drive by means of a Chabelco chain passing entirely around the drum. The unit is charged by means of a large door in the top of the drum, and discharges through a chute and sub-chute at the center rear. The rate of discharge can be regulated according to conditions at the site. Water is taken into the self-contained tank while the drum is being charged, the amount being regulated by a cutoff sight gage so that the exact quantity necessary can be obtained.

New Publications

Welding Pipe—The correct title of the 77-p. illustrated book on the welding of steel and wrought-iron piping reviewed on p. 504 of our issue of March 20 is "Oxwelded Construction for Modern Piping Services." It is published by the LINDE AIR PRODUCTS Co., New York City.

Water Turbines—Small water turbines of the reaction, inward flow or vortex type, are described in a 16-p. catalog issued by the DE LAVAL STEAM TURBINE Co., Trenton, N. J.

Vibrating Screens—Construction details, dimensions, capacity data and installation photographs dealing with the new vibrating screen of the STEPHENS-ADAMSON MFG. Co., Aurora, Ill., are given in a 16-p. illustrated catalog printed in color.

Steel—AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC., New York City, has started the publication of a monthly news digest containing information of broad and general interest in the field of steel construction. The institute has also issued a revised edition of its "Fact Book," which contains not only a statistical review of the steel industry but also a directory of steel constructors, a bibliography of engineering literature, motion pictures and stereoptican slides, and many additional data. The volume is intended as a handy reference for those writing or lecturing on steel construction.

Bucket Loaders—NEW ENGLAND ROAD MACHINERY Co., South Boston, Mass., describes its model 3 crawler-mounted bucket loader in a 14-p. illustrated catalog just issued.

Deep Well Pumps—Construction features of the Layne vertical centrifugal pump are described in a folder issued by LAYNE & BOWLER, INC., Memphis, Tenn.

Grading Equipment—Recent bulletins issued by W. A. RIDDELL Co., Bucyrus, Ohio, describe Warco graders and wheeled scoops.

Excavators—Bucket and wheel type trenching machines, a combined tamper and backfiller and a curb digger are described in the new general catalog of the CLEVELAND TRENCHER Co., Cleveland, Ohio. Other products covered include sectional steel manhole forms and accessories for underground conduit work.

Bar Joists—Standard specifications and safe loading tables for Macomber bar joints in tabular form have been issued in a revised edition by the MACOMBER STEEL Co., Canton, Ohio. This company has also issued a 4-p. folder describing accessories for use with the joists.

Excavating Machinery—An unusually attractive 20-p. booklet illustrated in color has been put out by the AMERICAN HOIST & DERRICK Co., St. Paul, Minn., describing its line of power shovels, cranes, hoists and derricks.

Piles—Advantage of the Ferry mushroom pile, a concrete cast-in-place pile with spread footing, are outlined in an 8-p. illustrated bulletin issued by the JAMES FERRY Co., INC., Atlantic City, N. J.

Central Heating—Condensed heating rates in tubular form covering the season 1929-1930, as charged by organizations distributing steam or hot water for district heating in the United States, are given in a pamphlet issued by the RIC-WIL Co., Cleveland, Ohio.

Winter Construction Equipment—MOHAWK ASPHALT HEATER Co., Schenectady, N. Y., has issued a bulletin briefly describing concrete heaters, thawing torches, water heaters, salamanders, car-thawing outfits and mortar heaters used in winter construction.

Screw Pumps—Advantages of the screw, propeller or axial flow pump, largely used for land drainage and similar purposes, are outlined in an illustrated booklet issued by the WASHINGTON IRON WORKS, Seattle, Wash. This describes Gill pumps, designed on the axial flow principle and consisting essentially of a bladed screw rotor, resembling in some respects a ship's propeller, working between guide vanes and surrounded by a short cylindrical casing. A distinguishing feature of these pumps is that the flow of water through the machine is not altered in general direction and there is little change in axial speed.

Purchasing—The significance and scope of the certification plan, by which certain manufacturers have stated their willingness to guarantee compliance with nationally recognized specifications for commodities, are discussed in miscellaneous publication 105 of the U. S. DEPARTMENT OF COMMERCE, Washington, D. C.

Costs and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Apr. 1, 1930	**207.12**	**March, 1930**	**408**
Mar. 1, 1930	206.80	February, 1930	204
Apr. 1, 1929	203.40	March, 1929	382
Average, 1929	207.02	Average, 1929	317
Average, 1928	206.78	Average, 1928	287
1913.....	100.00	1913.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of April 10, with some comparisons, total as follows:

(In Thousands of Dollars)

	Apr. 10, 1930	Average Preceding Four Weeks 1930	1929
Buildings:			
Industrial.....	$9,111	$11,834	$9,481
Other	29,892	45,048	56,712
Streets and roads..	13,366	11,450	5,412
Other eng. constr..	33,420	39,389	22,100
Total.....	$85,789	$107,797	$93,707
Total, all classes, Jan. 1 to Apr. 10:			
1930			$987,129
1929			1,294,585

Business Notes

TRADE PRACTICE RULES for the concrete mixer and paver industry, recently approved and accepted by the Federal Trade Commission, will be enforced by a committee of the industry headed by A. P. Robinson, of the Ransome Concrete Machinery Co. The work will be handled through a secretary, C. S. Embrey, located at 630 Munsey Building, Washington, D. C. Copies of the rules adopted and a suggested procedure for complaints have been incorporated into a 12-p. pocket-size booklet for the information of those concerned.

TRUSCON STEEL Co., Youngstown, Ohio, has appointed Oscar W. Loew a vice-president of the company. Mr. Loew has been director of advertising and sales promotion during the past six years.

GLAMORGAN PIPE & FOUNDRY Co., Lynchburg, Va., has appointed G. H. Jewell Western sales manager.

AMERICAN AIR FILTER Co., INC., Louisville, Ky., formed as a consolidation of the Midwest Manufacturing Co., the National Air Filter Co. and the Reed Air Filter Co., will hereafter function as one organization.

LINCOLN ELECTRIC Co., Cleveland, Ohio, has opened new offices in Saginaw, Mich., in charge of J. E. Luter; at Fort Wayne, Ind., in charge of D. H. Carver; and at Oil City, Pa., in charge of E. D. Anderson.

HERCULES POWDER Co., Wilmington, Del., has elected officers for the ensuing year as follows: president, R. H. Dunham; vice-presidents, J. T. Skelly, T. W. Bacchus, N. P. Rood, C. D. Prickett, G. G. Rheuby and C. A. Higgins; treasurer, C. C. Hoopes; secretary, E. B. Morrow.

NAYLOR PIPE Co., Chicago, Ill., has appointed Joseph V. McMullan foreign sales manager, with headquarters in New York City. Mr. McMullan will continue as New York district sales manager.

CHICAGO PNEUMATIC TOOL Co., New York City, has opened new branch offices in Oklahoma City, Okla., Tulsa, Okla., and Houston, Tex.

CONTINENTAL MOTORS CORP., Detroit, Mich., has appointed Louis J. Kanitz general sales maanger. For the past three years Mr. Kanitz has been in charge of the industrial engine division.

LUDLOW VALVE MANUFACTURING Co., Troy, N. Y., has elected James H. Caldwell chairman of the board. Mr. Caldwell has been associated with the company as general manager for 41 years, during 27 of which he has also been president. He will be succeeded as president by William H. Lolley, who is also director and general manager.

NATIONAL POLE & TREATING Co., Everett, Wash., will improve and expand its plant capacity from five to eight cars a day at a cost of $70,000. Installations will include a new creosoting unit, including two treating vats with capacity of three cars daily and a pipe line.

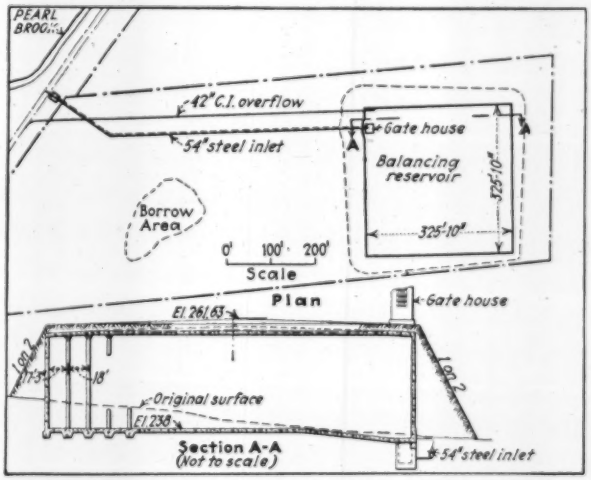
COPPERWELD STEEL Co., Glassport, Pa., announces the appointment of Edwin N. Hazlett to its sales engineering department. Mr. Hazlett is a graduate of the University of Pittsburgh and has been connected with the distribution department of the Duquesne Light Co., McKeesport, Pa., on transmission operation work.

DAVID P. THOMPSON, assistant to the president of the Inland Steel Co., Chicago, died March 24 at Miami Beach, Fla., of pneumonia. He was born at Newcastle, Pa., in 1880, and after being graduated from Yale University he entered the service of the Republic Iron & Steel Co. Later he became president of the Sharpesville Furnace Co., Sharon, Pa., and in 1912 he entered the employ of the Inland Steel Co.

Unit Prices From Current Construction Bids

Wanaque Aqueduct's $251,000 Covered Reservoir (N. J.)

A BALANCING reservoir (Contract 35) in connection with the Wanaque aqueduct of the North Jersey District Water Supply Commission was let in March, 1930, to Monroe & Westcott, Inc., North Attleboro, Mass., for $251,000. The work consists of a 15,000,000-gal. covered concrete reservoir, a 54-in. steel pipe line connecting the reservoir with the steel pipe of Wanaque aqueduct now being built under another contract, and a 42-in. cast-iron pipe overflow



PLAN AND SECTION OF WANAQUE BALANCING RESERVOIR

line from the reservoir to an abandoned concrete conduit adjacent to the aqueduct (see map). Appurtenant control valves and a 6-in. supply main form a minor item of the work, which is near the south portal of Great Notch tunnel in Clifton, N. J.

The principal items and their per cent of the low bid are: earth excavation (10), concrete masonry (35), cement (13) and reinforcing steel (19).

Earth excavation includes earth boulders of less than ½ cu.yd. and placing such material as is necessary as roof cover, embankment, refill, and for roadway and general grading. Borrow material is paid for separately. Wherever possible the trench bottom is to be shaped by templet to fit the masonry or pipe. Excavation for masonry structures is not to be dug by machinery nearer than 3 in. to finished subgrade, the last 3 in. being removed by handwork just before concreting.

Rock excavation to the amount of 2,000 cu.yd. is provided for. In rock trench a bottom space of 6 in. is left between rock and pipe, the trench bottom to be brought to grade by material properly compacted.

Pipe—Cast-iron pipe and specials for the 6-in. and 42-in. lines aggregate 235 tons. Item 8 includes full lengths of standard bell-and-spigot of 6-in. or more, and the average of six lowest bidders is $58 per ton in place. Item 9 includes pipe smaller than 6-in., flanged, cut pieces of bell-and-spigot, and all specials, valve connections and wall castings. Joints are calked with jute or other approved material and filled 2½ in. deep with lead, and calked.

Item 10 includes total cost of the 54-in. steel pipe in place. Steel pipes may be lock-bar, hammer-welded or double-riveted, in 30-ft. lengths.

Pavement—Item 12 provides for 975 sq.yd. of bituminous macadam for driveways, to be applied after completion of all structures affecting the road work. Subgrade is shaped and rolled for a 3-in. base course of stones (1½ to 3½ in.) rolled. The surface course is trap rock (⅜ to 2½) rolled to 3 in. thick. Immediately after applying the binder (Tarvia X or equal) a layer of stone (¼ to 1½ in.) is spread and rolled, and covered with asphaltic cement on which is spread dust-less screenings ⅜-in. on grades up to 5 per cent and ½-in. on steeper grades. Seven of the bids received were between $1.50 and $1.80.

Seventeen bids were received, the second being from Cenedella & Co., Milford, Mass., for $254,795, or 1.5 per cent above the low. These two bids are listed in the accompanying tabulation. Fuller & McClintock are the engineers.

Item	Description	Quantity	Monroe & Westcott, Unit Price	Monroe & Westcott, Amount	Cenedella Unit Price
1	Earth excavation, cu.yd.	25,000	$1.00	$25,000	$1.20
2	Rock excavation, cu.yd.	800	4.00	3,200	4.00
3	Borrow, cu.yd.	2,000	0.70	1,400	0.85
4	Concrete masonry, cu.yd.	8,000	11.00	88,000	11.75
5	Cement, bbl.	10,000	3.25	32,500	2.80
6	Steel for reinforcing concrete lb.	975,000	0.05	48,750	0.048
7	Miscellaneous metal work, lb.	15,000	0.15	2,250	0.10
8	Bell-and-spigot cast-iron pipe, tons	220	60.00	13,200	56.00
9	Cast-iron pipe specials, tons	15	160.00	2,400	160.00
10	Steel pipe, tons	115	165.00	18,975	181.00
11	Valves		9,000.00	9,000	9,000.00
12	Bit. macadam pavement, sq.yd.	975	3.00	2,925	1.60
13	Gate house		3,500.00	3,500	3,500.00
	Total			$251,100	$254,795

Canal, Levee, Bridge, at New Orleans

THE Board of Levee Commissioners of the Orleans Levee District opened bids Feb. 24, 1930, for the Donner canal and levee. Fig. 1 is a typical section of the canal, which is unlined. Excavation totals 800,000 cu.yd. and amounts to 89 per cent of the cost. The remaining items are piles and

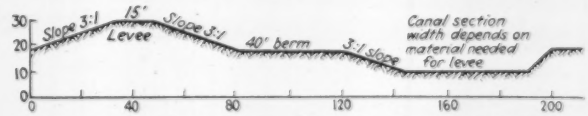


FIG. 1—TYPICAL CROSS-SECTION OF CANAL AND LEVEE

timbers for a highway bridge, and two concrete culverts. The crossing is a simple pile of timber bridge (Fig. 2) of eleven 15-ft. spans. The culverts are the smallest items of cost. Four bids were received: (1) Callahan-Walker (contract), Omaha; (2) T. H. Brockman, New Orleans; (3) Canal Construction Co., Memphis; (4) McWilliams, New Orleans.

		1	2	3	4
800,000 cu.yd. excav.	16.95c.	$135,600.00	20½c.	22.71c.	23.3c.
1,650 lin.ft. creo. piles	$2.50	4,125.00	80c.	$1.25	$1.40
18,000 b.f. creo. timber	300.00	5,400.00	$150.00	125.00	128.00
18,000 b.f. untreated timber	150.00	2,700.00	110.00	100.00	96.00
Culverts		3,600.00			
Culvert at Point Beka station—493+33		850.00			
		$152,275.00	$172,400.00	$189,639.75	$197,272.00

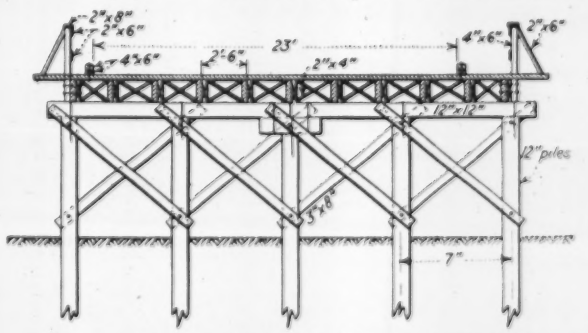


FIG. 2—CROSS-SECTION OF HIGHWAY BRIDGE

Unit Prices From Current Construction Bids

Roadwork in Mississippi

CONTRACT awarded in March, 1930, by the highway department of Mississippi for state project 197-B, 8.2 miles, between Forest and Lake, to Shoptrine Construction Co., Birmingham, for $63,734.57. Work consists of clearing, common excavating and bridge work. Six bids were received, the two nearest low being: (B) Boddie Construction Co., Laurel; (C) J. A. & H. E. Pigford, Russell.

	A	B	C
30 acres clearing (lump sum)	$1,000.00	$1,000.00	$1,800.00
30 acres grubbing	90.00	100.00	100.00
11,403 cu.yd. common excav.	0.26	0.30	0.30
94,201 cu.yd. borrow excav.	0.24½	0.30	0.30
120 lin.ft. 18-in. culvert pipe	2.00	2.00	2.00
318.4 cu.yd. class A conc.	19.00	21.50	20.00
31,932 lb. reinf. steel	0.044	0.04½	0.04½
4.5 mi. Bermuda sodding	70.00	75.00	75.00
112 R.O.W. markers	2.00	1.25	1.50
Bridges			
677.3 cu.yd. Class A conc.	19.00	22.00	22.50
101,250 lb. reinf. steel	0.044	0.04½	0.04½
550 lin.ft. conc. handrail	1.90	1.50	1.50
1,974 lin.ft. foundation piling	0.65	0.60	0.45
	$57,940.52	$66,237.79	$66,291.49
10 per cent eng. and contingent	5,794.05	6,623.77	6,629.14
Total	$63,734.57	$72,861.56	$72,920.63

Working days, 150

State Highway Bridge Near Pittsburgh

BIDS were opened Feb. 25, 1930, and contract awarded in March for a 763-ft. deck plate girder cantilever bridge over Turtle Creek on Moss Side Boulevard, in Allegheny County, near Pittsburgh. Four bids were received, and the unit prices of the lowest two are given in the accompanying tabulation. The first three items include shop painting and delivery at site. The last item is in place. The two bidders are: (A) Independent Bridge Co. (contract), Neville Island, Pa.; (B) American Bridge Co. Contract for the electric work was awarded to K. K. Wood Co., Turtle Creek, for $6,540.

	A	B
41,200 lb. c. steel	$0.06	$0.0925
28,000 lb. c. iron	0.05	0.075
2,520,000 lb. copper-bearing carbon steel	0.038	0.0384
Erecting above materials	0.0155	0.0152
3,200 lb. chrome-nickel-iron alloy	0.75	0.80
	$142,440	$144,995

Standard Items of Toledo Sewage-Treatment Works

BIDS for contract 21, covering excavation, hydraulic fill, concrete and timber retaining walls, building superstructures and tank equipment for the Toledo sewage-treatment plant were asked in August, 1929, but contract was not awarded until December.

The plant is to be built on an island too small to accommodate it, and hence requires cofferdam and fill work, as provided by item 66 of the accompanying tabulation of standard items. The principal portion of the digestion tanks will rest on this filled ground. The construction of these 85-ft. tanks is probably the most difficult operation of this contract.

The general excavation should be in the dry and give no difficulty. Concrete work is mostly bulky and heavy, except for some intricate formwork in the top portions of the structures, which explains the price of item 3.

The timber piles (item 9) are 35 ft. and in good driving ground. A land rig can be used, as the prices indicate.

Facilities for handling materials are good, with a railroad siding within 1,500 ft. and the possibility of unloading from barges to site. H. P. Jones & Co., Toledo, engineers.

TABULATION OF BIDS ON SEWAGE-TREATMENT WORKS FOR THE CITY OF TOLEDO, OHIO

Description of Items	Item No.	Quantity	E. H. Latham Co., Columbus, O. Unit Price	E. H. Latham Co., Columbus, O. Amount	Walker Const. Co. San Antonio, Tex. Unit Price	Holmes Const. Co. Wooster, Ohio Unit Price	A. Bentley & Sons Toledo, O. Unit Price
Earth excavation, cu.yd.	1	23,000	$2.00	$46,000.00	$2.05	$1.50	$1.05
Class A concrete, cu.yd.	2	7,800	14.40	112,320.00	14.25	14.15	14.55
Class A concrete, with super cement, cu.yd.	3	3,800	17.90	68,020.00	15.85	15.00	19.75
Class C mortar concrete, cu.yd.	5	450	14.22	6,399.00	13.70	13.50	14.44
Reinforcing steel (new billet steel), lb.	6	1,400,000	0.04½	59,500.00	0.042	0.041	0.0394
Reinforcing steel (rail steel), lb.	6 alt.	1,400,000	0.036	50,400.00	0.039	0.039	0.0374
Reinforcing steel mesh, lb.	7	22,000	0.084	1,848.00	0.09	0.09	0.07½
Waterproofing, sq.ft.	8	80,000	0.0275	2,200.00	0.04	0.03	0.037
Timber piles, lin.ft.	9	94,000	0.56	52,640.00	0.60	0.54	0.49
Sheeting and timbering left in place, M. ft. b.m.	10	100	10.00	1,000.00	5.00	10.00	1.00
Sheeting for retaining walls, M. ft. b.m.	10.1	350	109.25	38,237.50	125.00	120.00	119.00
Timber for retaining walls, M. ft. b.m.	10.2	75	111.48	8,361.00	125.00	115.00	123.00
Steel sheeting left in place, lb.	11	265,000	0.036	9,540.00	0.045	0.035	0.038
Painted asphalt joints, sq.yd.	15	1,200	0.25	300.00	0.50	0.30	0.36
B. & S. c. i. pipe 4 in. and smaller, tons	16	13	110.00	1,430.00	90.00	108.00	127.00
B. & S. c. i. pipe 6 in. and larger, tons	17	85	93.50	7,947.50	83.00	85.00	85.00
Flanged c. i. pipe 4 in. and smaller, tons	18	3	192.50	577.50	200.00	180.00	152.50
Flanged c. i. pipe 6 in. and larger, tons	19	6	176.00	1,056.00	190.00	160.00	127.10
B. & S. c. i. specials 4 in. and smaller, tons	20	7	192.50	1,347.50	170.00	170.00	172.00
B. & S. c. i. specials 6 in. and larger, tons	21	43	176.00	7,568.00	170.00	160.00	161.00
Flanged c. i. specials 4 in. and smaller, tons	22	12	220.00	2,640.00	245.00	130.00	211.00
Flanged c. i. specials 6 in. and larger, tons	23	20	209.00	4,180.00	240.00	210.00	207.00
Gate valves 1 in.	31	40	1.92½	77.00	2.05	1.50	1.80
Gate valves 1¼ in. bronze body, screwed	32	20	2.75	55.00	2.65	3.00	2.45
Gate valves 1½ in. bronze body, screwed	33	20	4.40	88.00	3.70	3.15	2.70
Gate valves 2 in. bronze body, screwed	34	10	6.60	66.00	5.00	4.30	3.90
Gate valves 2½ in. bronze body, screwed	35	10	11.00	110.00	10.00	8.00	7.66
Gate valves 3 in. iron body, screwed	36	64	14.30	915.20	14.00	9.50	9.00
Gate valves 4 in. iron body, fl. or bell	37	5	19.80	99.00	20.00	15.00	18.50
Gate valves 6 in. iron body, fl. or bell	38	56	27.50	1,540.00	29.00	25.00	25.50
Gate valves 8 in. iron body, fl.or bell	39	2	44.00	88.00	45.00	42.00	38.40
Gate valves 10 in. iron, fl. or bell	40	12	88.00	1,056.00	65.00	100.00	47.15
Gate valve 12 in. iron body, fl. or bell	41	16	110.00	1,760.00	75.00	110.00	62.50
6 in. valve floor stands	44	8	39.60	316.80	40.00	60.00	38.00
12 in. valve floor stands	44.1	8	39.60	316.80	40.00	70.00	46.00
Galvanized steel subway grating, sq.ft.	46	300	1.28	384.00	1.30	1.10	1.10
Miscellaneous cast iron, lb.	47	70,000	0.05	3,500.00	0.07	0.08	0.075
Miscellaneous wrot. iron and steel, lb.	48	290,000	0.08	23,200.00	0.09	0.095	0.083
18 in. vit. pipe drain, lin.ft.	51	1,400	0.253	354.20	1.00	0.45	2.05
6 in. vit. pipe drain underdrains, lin.ft.	51.1	4,600	0.18	828.00	0.25	0.20	0.18
Sand fill, cu.yd.	52	1,000	1.91	1,910.00	2.50	3.00	2.00
Hydrants	63	4	55.00	220.00	70.00	60.00	73.90
Cinder fill, cu.yd.	64	2,700	2.20	5,940.00	2.40	1.90	1.85
Loose stone, cu.yd.	65	130	3.85	509.50	3.00	3.50	3.10
Hydraulic fill, cu.yd	66	87,000	0.40	34,800.00	0.37½	0.40	0.43
Earth embankment, cu.yd	67	22,000	0.45	9,900.00	0.30	0.45½	0.49
Totals				$745,479.50	$776,834.00	$729,563.00	$732,756.40